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SCIENTIFIC AMERICAN

The Monthly Journal of Practical Information

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EXTENDING THE CONTRACTOR'S WORKING DAY BY FLOOD LIGHTING

Scientific American Publishing Co., Munn & Co., New York

Lincoln, who in the midst of great things found time for small, on the bed rock of whose belief two industrial pioneers builded; on the inspiration of whose spirit stands much of our present day industrial and national achievement.

Two Men Who Knew Lincoln

"LET'S go out tomorrow and see the thing shoot," said Lincoln. So began Christopher Spencer's career.

The story is told for the first time in this issue of the Scientific American. It is one of the last of the personal testimonies—they grow rarer as the years pass—of the imperishable kindness and the untiring interest in human affairs that were Abraham Lincoln's.

Wrestling as he was night and day with the death struggle of a nation divided against itself, the President yet made time for the young inventor who believed he had found something the nation could use. "Let's see it shoot," said Lincoln. So the vision became actual.

THERE was another young man who was helped by the President in those same days of national stress. His was the vision of drop forging pistol parts, to accelerate the supply of much needed weapons for the northern forces. Him, too, the President found time to encourage, and to C. E. Billings the message came:

"Go ahead and drop forge."

Two visions made actual by the man who found time for small things in the midst of great ones.

GIVEN the oak, it profits us not only to think of the acorn, but also of the sun and the rain and the long days of kindly time—for so we may remember that the oak is the product not of the acorn alone.

Given a great industrial achievement, it profits us to think not only of the acorn of vision in the minds of two men from which it sprang.

Something else was there: the belief of Abraham Lincoln.

VISION and belief! Great enough things to build on, even as the Billings & Spencer Company of Hartford has been built, to endure through the decades, to spread its products all over the civilized world, to hand down from father to son an unchanging ideal of endeavor and achievement.

Tall, gaunt, black-coated: the face deep lined, the eyes keen and far seeing under the bushy eyebrows—

To Spencer he said, "Let's see the thing shoot." To Billings, "Go ahead and drop forge."

"GO ahead and drop forge."

The Billings & Spencer Company has obeyed orders.

This advertisement is published by the Billings & Spencer Company, of Hartford, manufacturers of hand tools, drop forgings and machinery. It is designed to supplement the article regarding Mr. Spencer's acquaintance with Lincoln which is published on pages 102 and 103 of this issue.

Will the Bearings in Your Car do this

In February of this year in a certain automobile plant a model car of new design was turned over to the chief tester. He was told to keep it on the road constantly until July first—that his allowable speed was 45 miles an hour—and that he was not to let anything interfere with his putting this car through the most gruelling tests he could find.

And so through February snows, March sleet, April rains, and May freshets, this tester sent his car ploughing, plunging, fighting. June first the speed limit was lifted. Through the scorching sun of the hottest June most of us have ever known he sped, often making as high as 800 miles in a day!

Then on July first, after 29,000 miles had been covered, our chief engineer was called to check the condition of the ten Timken Tapered Roller Bearings in that car.

The differential bearings had made 18,357,000 revolutions. The pinion bearings had made 83,000,000 revolutions!

The brunt of the hard-going had been borne by the wheel bearings, and in two of them our engineer found barely perceptible signs of wear. But the taking up of one of the front bearings a single notch, and the other a half notch restored the entire bearing equipment quickly and easily to its original ability to function properly under all loads, at all speeds.

Twenty-nine thousands of such tortuous miles as but few automobiles ever travel! Millions and millions and millions of revolutions under full load and at terrifying speeds! Yet the Timken Tapered Roller Bearings were restored by easy adjustment. Even at 100,000—200,000—and more, miles a similar slight adjustment will make Timkens function in wheels, transmissions, pinions, differentials, as if they were new.

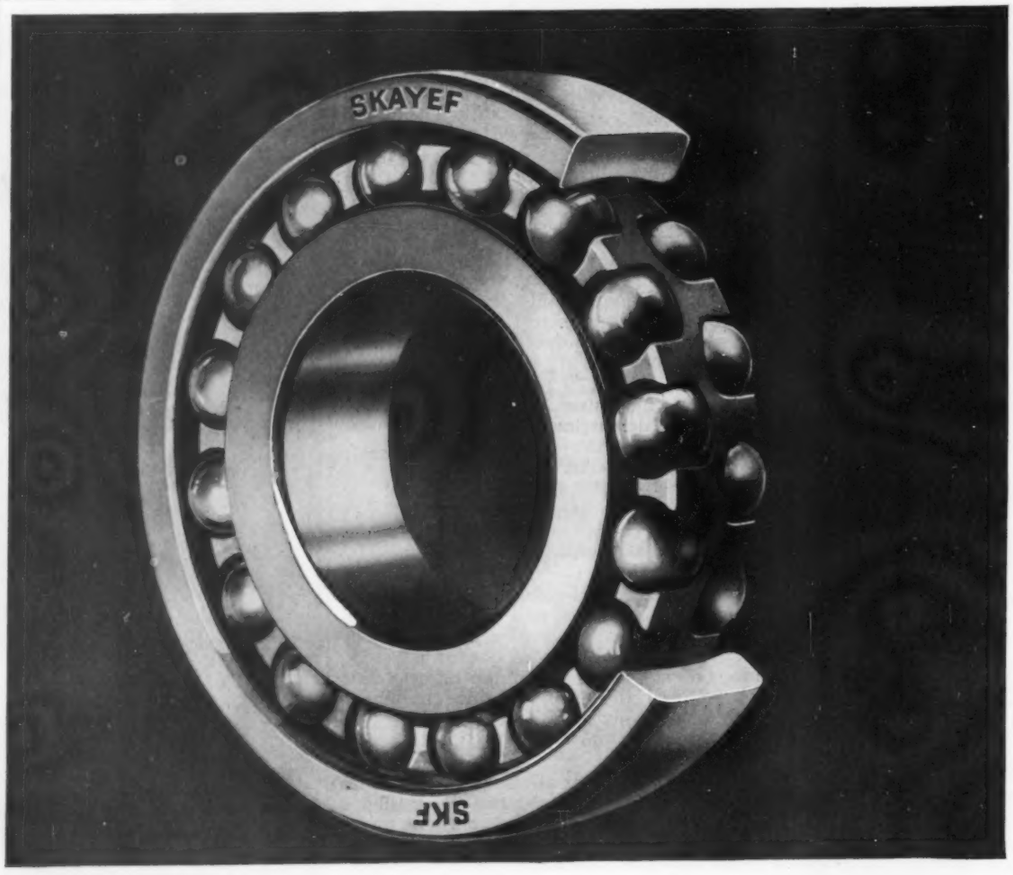
It is just that ability of Timkens to withstand wear, and just that easy adjustability to the wear that eventually *must* follow all motion, which means such a satisfying peace of mind to those owners who drive vehicles built by the 422 American and European manufacturers who use Timken Tapered Roller Bearings in their automobiles, trucks, and tractors.

The Timken Roller Bearing Co, Canton, Ohio

Timken Tapered Roller Bearings for Passenger Cars, Trucks, Tractors, Trailers, Farm Implements, Machinery, and Industrial Appliances

TIMKEN *Tapered* ROLLER BEARINGS

THE SCIENTIFIC AMERICAN, December, 1921. Volume 125-A, Number 18. Published monthly by Scientific American Publishing Company at 233 Broadway, New York, N. Y., Subscription price, $4.00 per year. Entered as second-class matter June 18, 1879, at the post office at New York, N. Y., under the act of March 3, 1879.



The modern, highly developed, self-aligning ball bearing

is due to the world-wide studies of SKF engineers, and the experience of The Skayef Ball Bearing Co. These made possible the development of the Self-Aligning bearing, whose special function besides carrying radial loads, is to compensate for shaft misalignment.

The entire engineering experience of our organization is at your disposal. You are urged to submit your bearing problems to us for careful and impartial consideration.

The Skayef Ball Bearing Co.

Supervised at the Request of the Stockholders by

SKF Industries, Inc.

165 Broadway, New York City

524

With the Editors

IN bringing out our first issue of the new monthly SCIENTIFIC AMERICAN, the November issue, we felt very much like the actor in a first-night performance. How would our readers take the change? was the question uppermost in our minds. Of course, decade after decade spent in catering to the wishes of practical Americans has made us very well acquainted with the likes and dislikes of our large circle of readers; but, nevertheless, there is no gainsaying the fact that we broke away from the general style of our former weekly and monthly editions. Like the actor already referred to, we waited for the response of our audience. And now, several weeks after the first issue of our new monthly has appeared, we find ourselves showered on all sides with letters and messages of a highly complimentary tone. The response has been most gratifying—far in excess of what we had dared to hope for; and, what is most important, we find many new readers expressing their satisfaction over our new form, along with our old-time readers and lifelong friends. It does seem as if we shall, therefore, continue to serve our friends of old, while extending our circle to many new readers. So much the better, for it must be obvious to all that the larger our audience the better and greater we can make our journal. We appreciate the hearty applause that has greeted our initial issue.

INFORMATION in tabloid form is the purpose of the various departments of this journal. In the preparation of the numerous notes which appear under various headings, we read a large number of domestic and foreign periodicals, Government reports, papers read before learned societies, and other technical literature. In fact, our list of "exchanges"—that is the name given to periodicals received in our office for the purpose of review—includes well over one hundred domestic and foreign publications, not to mention the numerous solicited and unsolicited Government and engineering reports which come to hand. From a five-page article we prepare a 200-word note, but in those 200 words we endeavor to cover the main points and those of greatest interest to the general reader. This boiling down process, as it were, is one of our most important jobs, and by no means the least interesting, even though the product may not be a true indication of the amount of time and effort spent in its preparation.

FROM that wonderful storehouse of knowledge, the Metropolitan Museum of Art, came the data and the illustrations for the article entitled "The Mechanism of the Pipe Organ," appearing on page 113 of this issue. This is by no means the first time we have turned to that institution for data and illustrative material, and we are pleased to feel that on so many occasions our columns have been the medium for extending the scope of the Museum's exhibits far beyond the limits of New York City.

THERE is no greater hobby than radio. Over 300,000 radio amateurs in the United States alone constitute ample proof of that bold assertion; but if further proof is required, it is a simple matter to point to the many large and small companies engaged in the manufacture of amateur radio equipment. From time to time we have been asked to consider radio seriously, especially the amateur phase, and to inaugurate a special radio section. Candidly, we are much in sympathy with the suggestion, for we have often donned the head 'phones and listened of an evening to the amateur and commercial transmitters in and about New York, with an occasional radio telephone thrown in for good measure. After weighing the matter carefully, we are of the opinion that even with our increased space allotment, it would not be possible to devote sufficient space for a real radio department. We believe there is a sufficient number of journals devoted exclusively to radio for the present needs; but—and here is the point—those journals live so close to radio that they are generally unable to report the big happenings in that field in every-day language for the benefit of the layman. It is our purpose, therefore, to keep close watch on radio developments, and to report current achievements of broad interest. "News and Music from the Air," on page 104, is typical of this purpose.

NO matter what may be the startling changes in this new monthly SCIENTIFIC AMERICAN, one feature stamps it as being of the same bone and sinew as the old SCIENTIFIC AMERICAN—the pictorial comparisons. Many years ago this journal set to work making facts and figures tell their story in picture form, and the "picturized" statistics that have appeared in these columns have been reproduced far and wide by newspapers, magazines, advertising men and others. The railroad comparison appearing on page 85, and the "Leading Armies of the World," on page 96, are typical of that technique. In making these comparisons, the SCIENTIFIC AMERICAN never allows itself to be led astray into the use of "pipe-organ" diagrams, with their mere straight lines of lengths corresponding to the magnitudes to be compared. We always did and always shall follow the pictorial style, where the thing itself is pictured more or less conventionally, the bulk or volume of the figure in three dimensions being usually, though not always, the vehicle of the numerical comparison.

OUR main problem is not so much the obtaining of sufficient SCIENTIFIC AMERICAN material as it is a matter of finding sufficient space. In the preparation of this issue we secured at least 50 per cent more material than we had space for, and it was with considerable disappointment that we placed aside certain articles for future issues. But some of this surplus material is a firm foundation for the January issue, which is certain to excel all previous efforts. There is, for example, an excellent review of the rise of illuminating engineering by M. Luckiesh, well-known illumination and color authority, which came in just a trifle too late to be included in this issue. The same may be said of Dr. E. J. Loring's article on bombing and bomb sights. Dr. Loring is an Army ordnance engineer who has specialized in aircraft armament. Still another, entitled "A Garbage Crisis," deals with a big problem confronting our large cities. A number of articles crowded out of this issue, but available for the January issue, deal with important engineering undertakings, such as the proposed Belt Line around Jersey City and New York, by Col. W. J. Wilgus, the new Alaskan Railway, the latest flood protection measures in the Miami Valley of Ohio, Philadelphia's elevated railroad, and so on. Dr. Harriss, New York's deputy police commissioner in charge of traffic, has promised to write something for us on the handling of traffic in and out of big cities.

CONTENTS

DECEMBER, 1921

LEADING ARTICLES

Prehistoric Sculpture	*By Henry Fairfield Osborn, Sc.D.*	86-87
The Role of Research	*By W. R. Whitney, Ph.D.*	88-89
Britain's New Battle Cruisers	*By Hector C. Bywater*	90
Railways of the World	*By the Staff*	91
Science in Safe-Breaking	*By Roy A. Giles*	92-93
The 4000-Pound Demolition Bomb	*By Maj. William A. Borden, U.S.A.*	94-95
Leading Armies of the World	*By the Staff*	96-97
The New Army Sixteen-Inch Gun	*By the Staff*	98
Seats for 125,000	*By the Staff*	99
Our Point of View	*Editorial Comment*	100-101
Abraham Lincoln and the Repeating Rifle	*By the Staff*	102-103
News and Music from the Air	*By Pierre Boucheron*	104-105
Our Reforestation Activities	*By Charles Frederick Carter*	106-107
Phosphorus, the Backbone of Life	*By George H. Dacy*	108
Why Weary Metals Fail under Light Loads	*By George H. Dacy*	109-110
The Revival of the Monoplane	*By Ladislas d'Orcy*	111-112
The Mechanism of the Pipe Organ	*By J. F. Springer*	113-116
The Oil and Albumen Content of Seeds	*By Ismar Ginsberg*	116
Engineering in Truck Tire Building	*By H. W. Slauson, M.E.*	117
The Banana and Its Uses	*By William A. Murrill, Ph.D.*	118-119
Recent Studies of the Venomous Snakes	*By J. Beyer*	119
Crossing San Francisco Bay by Bridge, Fill and Tunnel	*By the Staff*	120-121
How Marine Worms Catch Their Prey	*By William Crowder*	122-123
A Map's Other Name Is Ananias	*By C. H. Claudy*	124-125
A Wilderness Industry	*By Felix Eugene Averill*	126-127
The Story of Sugar	*By Arthur L. Dahl and Rozel Gotthold*	128-130
A Climax in Concrete Construction	*By Robert G. Skerrett*	132-133

SHORT ARTICLES

America's First Model Airway	89	Rock Crystal Balls	125
High-Speed Fighting Ships	97	Acetylene as Auto Motor Fuel	125
Stainless Iron—a New and Striking Product	99	Keeping Growing Potatoes Cool	127
The Mechanics of Ordnance Figures	105	The Self-Supporting College	130
Difference between Molds and Wood Destroyers	112	Moss Scrubber for Irrigation Projects	131
Restoring Sight to Blind Animals	117	How More Light Speeds Up Vision	131
Fire Tests of Building Columns	121	Muscle	131
Freak Boiler Explosion with a Man Inside	121	The Camera Turned Sculptor	135
		Static and Gasoline Fires	135
		Eliakim Hastings Moore	137
		Zirconium, the "Mystery Metal"	137

DEPARTMENTS

The Service of the Chemist	134	Electrical Notes	151
The Heavens in December	136	Aeronautical Notes	152
Inventions New and Interesting	138–141	Mechanical Notes	153
Recently Patented Inventions	142–145	Notes and Queries	155
Book Reviews	148	Science Notes	156
Miscellaneous Notes	149	Civil Engineering Notes	157
Patents and Trademarks	150	Index to the Volume	159–160

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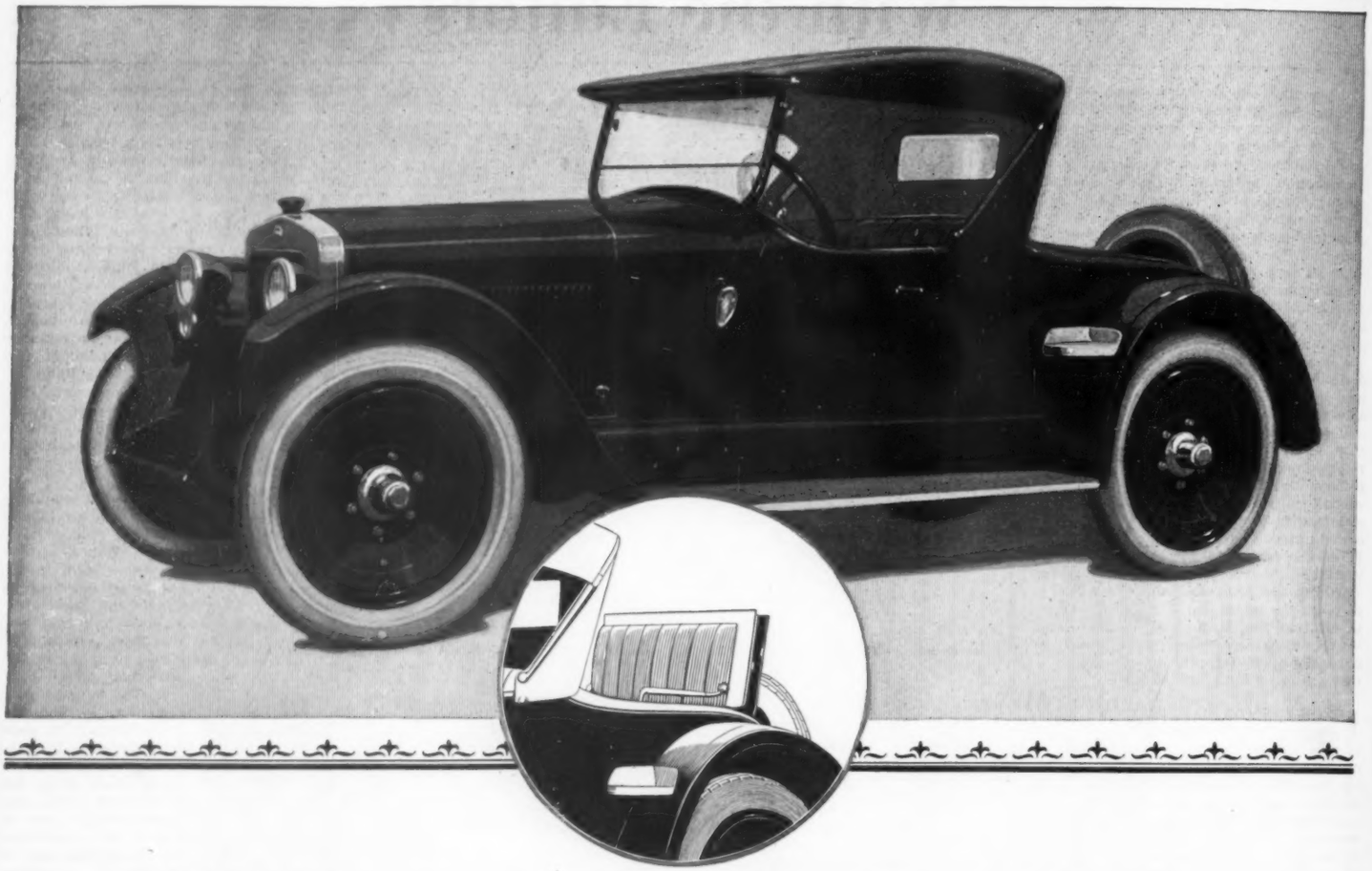


WILLS SAINTE CLAIRE

The Mo-lyb-den-um Car

THAT car that quickly and easily passed you on the boulevard—
That went comfortably over that rough piece of road without slowing up—when you had quickly to apply your brakes—
That seemed to fly through space on wings as it whizzed by you on the hill—
That made the turn with such ease, without slowing down—
That was a Wills Sainte Claire, carrying an owner enthusiastic regarding its new sense of comfort and security, its Mo-*lyb*-den-um construction, its graceful design and remarkable acceleration.

You are invited to give the Wills Sainte Claire most critical examination and road test. It very promptly demonstrates its superiority.

The 8-cylinder Wills Sainte Claire is built in four models—5 Passenger Touring Car, 4 Passenger Roadster, 4 Passenger Coupe, and the Sedan, with 2 auxiliary seats

C. H. WILLS & COMPANY
Marysville, Michigan.

Four-Passenger Roadster

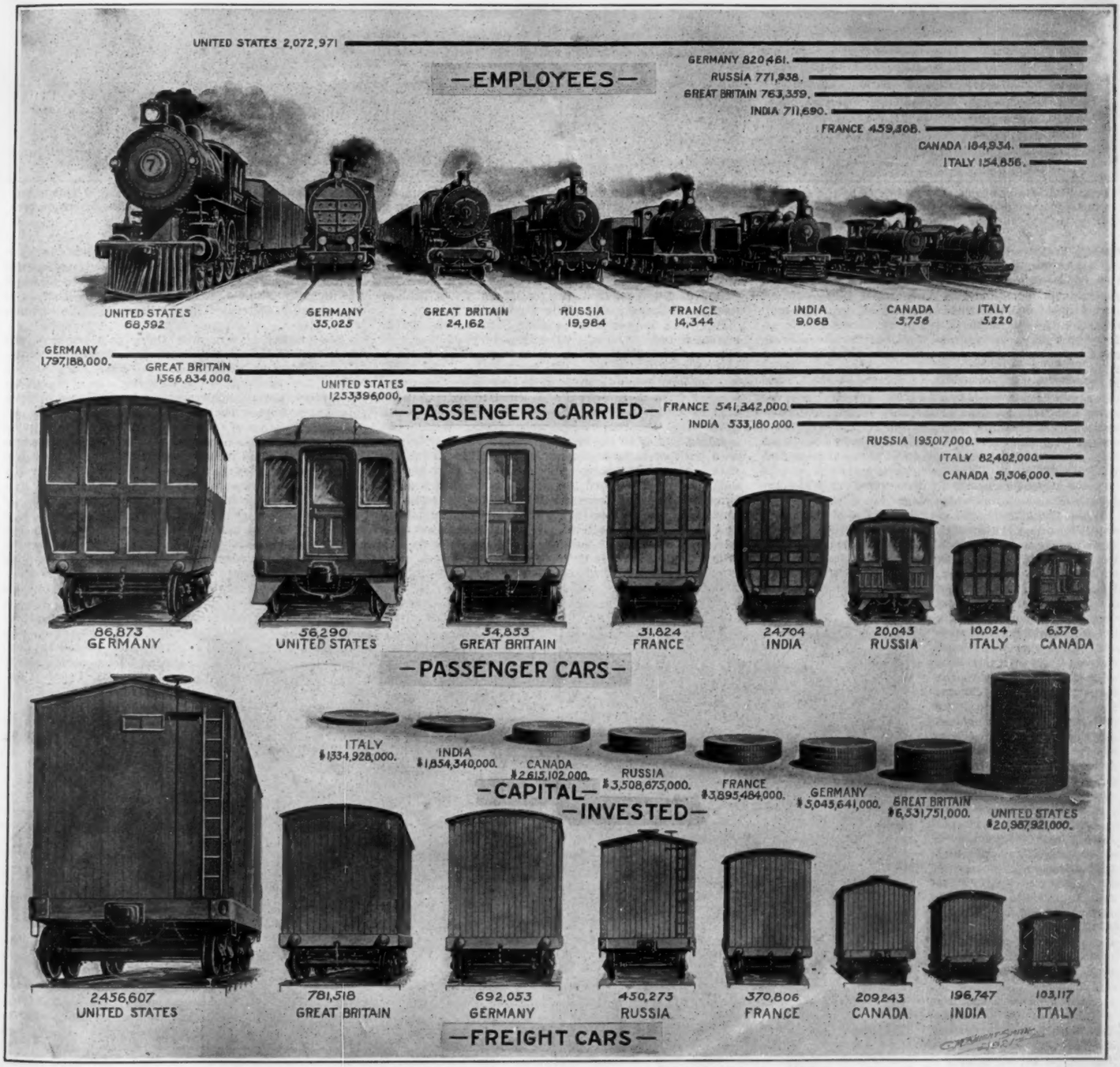
A car for the man who loves action—Rumble seat in rear accommodates two persons comfortably—Body finished in maroon, Newport blue, or Liberty green.

SEVENTY-SEVENTH YEAR

SCIENTIFIC AMERICAN

THE MONTHLY JOURNAL OF PRACTICAL INFORMATION

NEW YORK, DECEMBER, 1921

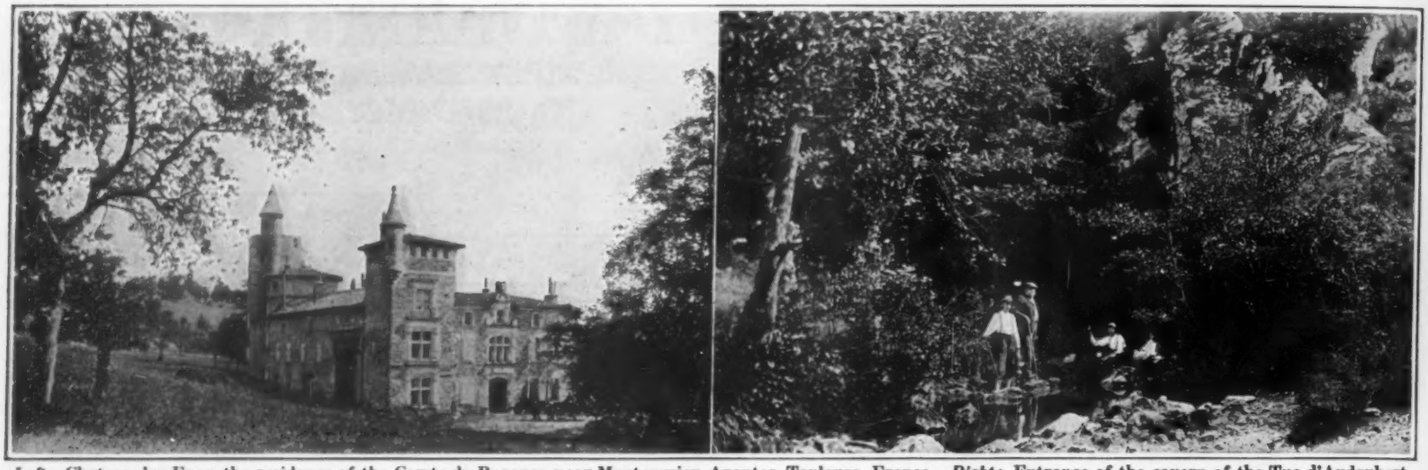


COMPARISON OF THE LEADING RAILROAD SYSTEMS OF THE WORLD. [See page 91]

Prehistoric Sculpture

An Account of the Discovery of Two Bisons Sculptured in Clay by the Crô-Magnons of 25,000 Years Ago

By Prof. Henry Fairfield Osborn
President, American Museum of Natural History



Left: **Chateau des Epas, the residence of the Comte de Begouen near Montesquieu-Avantes, Toulouse, France.** ***Right:*** **Entrance of the cavern of the Tuc d'Audoubert exactly as it appeared at the time of its discovery when visited by the writer in 1913. Comte de Begouen with his three sons (Les Trois Freres), two of whom are in the small home-made boat in which they entered the cavern.**

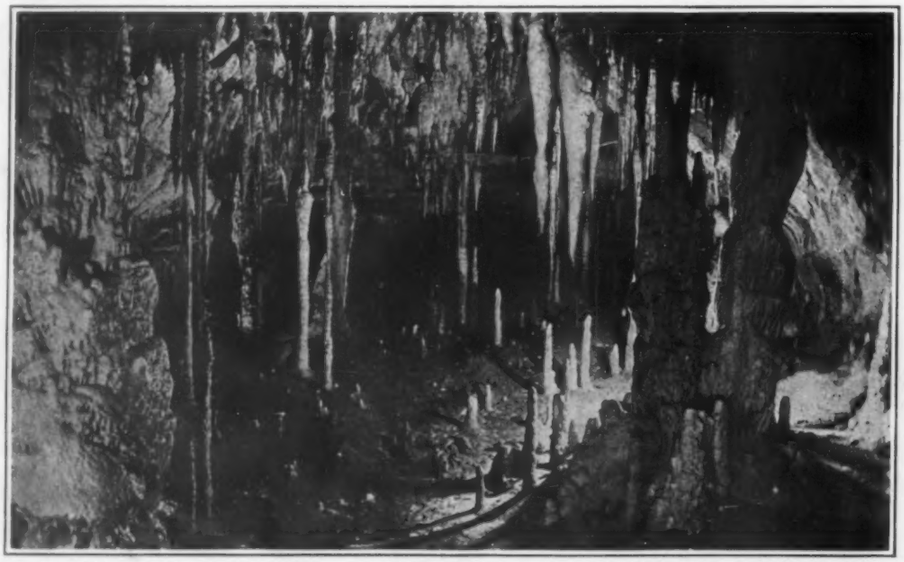
THE prehistoric men of Italy, Spain, and France sought the great belt of Cretaceous limestone for their shelters, for their fireplaces (known in France as *foyers*), for their temples and, when the great art period developed, for their galleries of drawings and, as this article narrates, of sculpture. Here were comforts, not of our sort, it is true, but far superior to anything they could create with their hands with the rude tools at their disposal. During the last great glaciation, the fourth of the series of ice waves from the Scandinavian peninsula and the Alps which swept down over Europe, men of the very inferior Neanderthal race occupied the shelters and entrances to these caverns, but thus far no evidence has been found that they actually penetrated the mysterious recesses beyond the entrance. These mysterious and even perilous recesses were frequented by the cave bear while the Neanderthal race was at its height.

When the artistic and courageous Crô-Magnon race entered Europe they not only drove out the Neanderthals and took possession of the shelters and caverns, but they soon began to penetrate the innermost labyrinths of the caves themselves, not apparently for prolonged residence, although fireplaces and small deposits of flints frequently occur deep within the caverns, but for development of their art. Limestone walls worn smooth by subterranean streams attracted the artists for engraving with flint and for painting, first in black and then in several colors. All this art is the work of one race very superior in endowment and with keen powers of observation and undoubted love and admiration for the beauty of animal life. Having now personally examined hundreds of drawings and paintings in the deep cavern recesses of France and Spain, I feel that I am quite justified in attributing these unusual faculties to a race that existed between twenty-five and forty thousand years ago.

About thirty of these art caverns have been found in France and Spain containing drawings, engravings, flint etchings and paintings, but not a bit of sculpture. This exception was suddenly removed early in the year 1914 by the discovery of two bisons sculptured in clay in an art cavern in the central Pyrenees in the heart of a small limestone mountain on the property of the Comte de Begouen, from the top of which one can see the whole central range of the Pyrenees.

In 1913 I happened to be near Saint Girons in the Pyrenees two days after the discovery of this new cavern, which received the name of the Tuc d'Audoubert. The discovery was made by the sons of the Comte de Begouen, mere striplings at the time, who had secured from their father permission to build a small boat in which they might paddle up the stream which flows from the entrance to the cavern. About two hundred feet from the entrance they found a limestone wall ten feet high, and clambering up they found the entrance to the cavern. Returning for an acetylene lamp, the boys explored the side walls, on which about three hundred feet from the opening they perceived a number of flint engravings. They hurried back home and communicated their discovery to their father, who hastened to the spot, and thus another cavern was added to the long list of those which have been made known by French archaeologists. Two days later I happened to arrive, accompanied by Professor de Cartailhac of the University of Toulouse. With characteristic French courtesy the Comte de Begouen insisted upon our being the first to enter the chamber in which the new drawings had been found. This memorable experience is described in my "Men of the Old Stone Age."

The original cavern was thoroughly explored and found to contain a few interesting etchings, but nothing of very great importance. A year later, however, just before the beginning of the war, the sons of the Comte discovered a very small opening leading upwards—an opening so narrow that it barely permitted the passage of the body, even of their small frames. They pursued their upward, sinuous course, crawling like salamanders on their faces and pushing their acetylene lamps before them through passage after passage, until finally they reached a large chamber about fifty feet long and thirty feet across, with ceiling about twelve feet in height. At the end of this chamber they found indications of a circle within which were the models of two bison, bull and cow, lying partly on the side. The models were in clay, as fresh as when they left the hands of the primitive sculptors twenty-five or thirty thousand years ago. This absolutely unique discovery astounded all the archaeologists of Europe. The chamber was termed the *salle des bisons* and soon after its discovery was visited by two leading archaeologists of France, Professor de Cartailhac and l'Abbé Henri Breuil.



Interior of the Tuc d'Audoubert. This is the "Salle Cartailhac," named in honor of Prof. Emile Cartailhac, who first explored this cavern with the writer. (Photograph by permission of Comte de Bergouen)

Last summer I had the first opportunity of seeing this *galerie supérieure* myself, accompanied by the Comte de Begouen; for in the meantime the three Begouen brothers have grown up, served with distinction in the World War, and have entered on their various careers. Our party consisted of the Comte, now of portly figure, two daughters of M. Lalanne, the archaeologist of Bordeaux, William Williams, former Commissioner of Immigration of the Port of New York, and myself. We entered the cave, each provided with an acetylene lamp and dressed in a miner's suit. We ascended a very long, narrow and difficult passage, with constantly increasing admiration of the enthusi-

asm and physical courage of the Comte and other French archaeologists which led them to explore this passage before any of the iron ladders, steps, and other aids to the ascent were prepared to facilitate the work and before certain obstacles in the narrow passages were removed. Even now the ascent is extremely arduous and one arrives at the *salle des bison* in a profuse perspiration but in a frame of mind ready to contemplate one of the greatest wonders of prehistoric art.

Each bison is about eighteen inches in length. The characters of the male and female are clearly indicated. The tool work is still fresh, and as the acetylene light is passed slowly around the sculpture one observes that these bison are two masterpieces, done in a very broad modern style, with absolute truth of proportion and truth of mass. Nearby is a third partly finished bison and a model of a fourth which may have been carried into the cave to aid the sculptor. Ten feet away are several rolls of fresh clay, indicating that the clay was carefully worked with the hands before being applied to the modeling process. The models themselves give the impression of having been carved out of a solid block of clay, with the addition of certain parts, like the tail, horns and mane, from the rolls of clay nearby.

The two bisons sculptured from the red clay found on the floor of the "salle de danse" in the cavern of the Tuc d'Audoubert. Left-hand figure represents a male, the right a female, bison. The models are supported by a central mass of clay exactly as they were left by the sculptors about 25,000 years ago. (Photograph by permission of M. Jean Brunhes)

About twenty-five feet away is a small depressed chamber called the *salle de danse*. Here are fresh hand and foot impressions, slightly coated with drippings from the limestone ceiling above. A number of heel marks are perfectly preserved, and the Comte de Begouen insisted on raising one of the natural casts of this heel of, perhaps, an ancient sculptor as a gift to the American Museum of Natural History.

No language or description can possibly convey to the mind the mysterious impression given by the chamber itself. One is overcome by the mystery of the great antiquity of the human sense of intelligence, of the human appreciation of art, perhaps of the religious sentiment which animated these sculptors of the Crô-Magnon age and inspired them to penetrate the deepest recesses of these caverns with very feeble lamps. The motive of sculpture may have been in a sense propitiatory to some superior power or divinity. This at least is the prevailing theory, which is strengthened by the discovery of a large chamber in a neighboring cavern which has received the name of *Les Trois Frères* in honor of the three sons of the Comte de Begouen who discovered it. Within *Les Trois Frères* the chamber is fairly covered with mural engravings. Every available foot of space has a design upon it, and in one corner of the ceiling is the figure of a sorcerer, or medicine man, not entirely dissimilar to the dancing figures found among some of our Indian tribes of the West, the head provided with horns and the back covered with the pelt of an animal, perhaps a wolf, from which is suspended a tail.

We have not the space to describe *Les Trois Frères* at greater length, but in the accompanying photographs the reader may see the entrance to the cavern of Tuc d'Audoubert, the two sculptured bison as they appear, and the etching of the figure of a horse in *Les Trois Frères*. This etching of the horse is highly characteristic of the resourcefulness of the Crô-Magnon artists. The originally light limestone wall is covered with a brownish tint deposit from the muddy waters of the stream which made the cavern. In order to represent the light natural coloring of the hair of this species of horse the artist, after sketching in his outline accurately, scratched off the brownish coating, exposed the light-colored limestone beneath, and thus portrayed with remarkable fidelity the light coloring of the under parts of the body which is observed in all species of wild horses. The greater number of drawings in the Caverne des Trois Frères are really etchings, executed by removal of the dark coating on the limestone walls, exactly as an etcher works today. We are indebted for permission to publish these photographs to the Comte de Begouen, who referred the writer to a forthcoming paper by one of the leading French archaeologists, l'Abbé Henri Breuil, for authentic description of the numerous etchings of many kinds of animals—horses, rhinoceroses, mammoths, reindeer, stag, cave bear—found within this remarkable cavern.

Recently discovered etching of the small Celtic horse (Equus caballus celticus) of the period, in the Caverne des Trois Freres. (Photograph by permission of the Comte de Begouen)

Precision Test of Large Capacity Scales

THE accuracy that can be obtained from large weighing scales is not generally known among engineers and others concerned in the subject. This paper outlines a scientific and systematic procedure for the accurate test of large capacity compound lever scales, by a method which has been developed and used by the Bureau of Standards, largely in connection with its work in testing railroad master track scales, and grain hopper scales; but the plan can be adapted to the test of almost any compound lever scale.

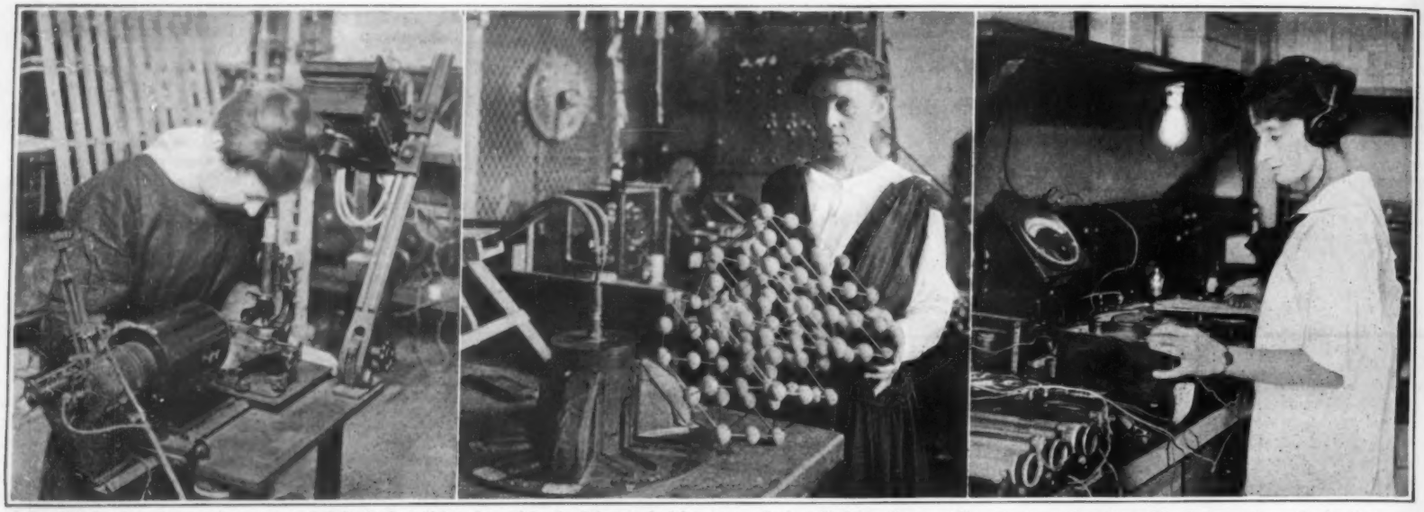
A pointed and graduated scale is arranged for reading the position of the beam; and the errors of the scale are determined from observations made upon the beam while it swings freely. The method of recording data and of determining the results is very similar to that which has been in use in laboratories for precision weighings on fine equal-arm balances. The method of taking and recording the data also tends to eliminate the personal equation, to point out where mistakes are made, when such occur, and gives a very complete record of the test which will present very understandable and detailed information to any one who has occasion to make a critical study of the test.

The method is not suggested for use in the regular routine testing of ordinary compound lever scales, where precision results are not required. The method given here requires the observance of certain details consistent with realizing precision, and requires training and ability to a greater extent in those making the test than is required in the ordinary case.

The procedure of the test is explained with the aid of a record form and computation sheet which was developed in connection with the successful application of the method in the field. In the interest of a uniform and efficient method the scheme outlined is recommended to those who have occasion to carry out tests on large scales where accuracy of a high order is required.

The Production of Liquid Air on a Laboratory Scale

THE essentials of a plant producing liquid air by the Hampson process are the compressor, purifying train and liquefier. The compressor, usually of four stages, delivers air at room temperature and approximately 3000 pounds per square inch. The compressed air purifying train consists of first, a trap for receiving oil and water, and secondly, suitable containers which are charged with chemical reagents, such as sodium hydroxide, calcium chloride, or lime, for removing carbon dioxide and water vapor. The air thus compressed and purified is delivered to the liquefier, in which, after passing through a coil of copper tubing, the air is allowed to expand freely to approximately atmospheric pressure. Where this drop in the pressure takes place there is a corresponding drop in the temperature of the air. The expanded air, before leaving the liquefier, is caused to circulate around the copper coil which contains the compressed air, thus cooling the coil and, in turn, the compressed air so that on continuous operation a cycle of progressive cooling is maintained until the temperature ultimately reaches the liquefying point. The liquefier is so constructed that the air which is condensed to liquid is delivered into a receiving vessel. The gaseous air exhausted from the liquefier is returned to the intake of the compressor for succeeding cycles because it has been purified, and when used repeatedly will be less exhausting on the purifying reagents. For laboratory production of liquid air this process leaves little to be desired.



Left: Metallurgist using a micrometer on infinitesimal particles of metal in the Schenectady laboratory. *Center:* Studying the crystalline structure of matter. The instrument on the bench is an X-ray camera for photographing structural features; the model is of a complicated crystal. *Right:* Testing high-power radio tubes

Three widely divergent activities of the Schenectady laboratory

The Rôle of Research

Creating New Things and Revising Old Things for the Industrial World

By W. R. Whitney, Ph.D.
Director, General Electric Research Laboratory

WHAT must America do to establish itself as the leader among nations in making natural forces do the world's everyday physical work?

This is not an academic question. We are in competition with others for world trade. The premiership will go to that nation which excels in learning how natural forces may be utilized in the continually expanding tasks of mankind, and in turning out the best devices for using those forces.

Shall we content ourselves with being only a nation of artisans carrying out the ideas of others, embodying the results of their discoveries; or shall we be leaders in new undertakings and in general advance? And if we aspire to excel in this field, what is necessary for success?

The principal essential is a body of trained investigators.

At first sight this may not be perfectly evident. We may not realize how much we depend on new discoveries. Unless growing we cannot live. The world is so constituted that the undertakings of one period are insufficient for the later one. Experience has shown us that even if we might exist like Islanders of the South Seas, it can never be generally done. It has instead, shown that our happiness, measure as we will, is extended by further efforts to appreciate things about us, to understand creation. Nowadays what most of us are doing depends upon some phenomenon or property of matter unknown a century ago which has now become a pillar of civilization. Only a few till the ground and work without modern tools. What most of us think and talk about, what most of us depend upon for our living, growing and playing, is the result of study recently added to study formerly expended. We start the day with a tempered bath, forbidden by law less than a century ago, because they didn't know its value. We use all sorts of devices for shaving and improving our health or appearance before we dress, and we are only interested in the most modern materials and styles for clothing. We breakfast on products derived from the most distant sources and prepared in entirely novel ways. We go to our work in a device unknown to our grandparents, whether it be train, street car or auto, and we spend our day working on something of which the vocabulary itself was not invented a few years ago. We dictate, telephone, telegraph and turn on and off the power for machines which represent a hundred times the physical strength of all the people together. The coal, the water and the gas are more necessary to our physical and mental make-up than wheat and corn. The more we have, the more we want, and nature encourages this rule by making every contribution to truth, about rearrangements of our surrounding materials, a manifold contribution to our horizon and our happiness. There is evidently no upper limit; what limit to improvements may exist is in us, not in the externals which we employ. Thus the trained investigator is like the successful pioneer, who, in the days of unopened territory, led the people to fertile home sites.

We have the other requisites. We have splendid laboratories. We have a wealth of materials with which to work. As a whole, we have abundant money for carrying on such work. But we must have competent men to use them.

A vast majority of the men engaged in research work today are college trained. Those of the future will probably be college trained. Hence, if we are to develop such a force as we must have in order to lead the world, the colleges in which they are educated will be the means for developing it.

If our colleges were today doing this to the maximum extent, there would be no question about our leadership. Hundreds of students are being graduated from scientific and engineering courses in American colleges and universities every year. It is not quantity that we lack. The call from existing industries has thus far demanded the quantity.

What are the necessary qualifications for research work?

Among them are interest in unknown things, imagination, persistency, ability to distinguish between what is essential and what is not essential. Ingenuity is an important asset, as is also resourcefulness. The research worker must know facts about matter—call it physics, mechanics, chemistry, electricity, or what not. The more he knows about his own science, other things being equal, the more he will accomplish; and the broader his knowledge of other sciences, the greater will be his ability.

Without inquisitiveness, initiative, and thorough ground work of knowledge in their chosen line, research men will make little progress. Research is really 90 per cent hard work—work of the most exacting, strenuous, exciting, but often disappointing sort; and if the men now in training for the further advancement of the boundaries of human knowledge along the line of doing the world's industrial work are to succeed, they will have to toil as they dream.

Drs. Whitney and Langmuir, head and assistant director of the G.E. research, and its guiding spirits

The research worker must be alert to recognize the magnitude of a discovery he may make even though it is useless for the particular purpose for which he sought to use it. For instance, Dr. Irving Langmuir, seeking to learn how oil spreads on water, discovered how to measure the size of molecules. He must be patient. It was at the end of ten years of experimenting that Dr. W. D. Coolidge learned how to make tungsten ductile—a discovery that has revolutionized the making of incandescent lamps.

America possesses ample material from which to develop research men excelled by none. But what about their training? Is the college of today doing its part in this development? Is it training investigators, or merely turning out human scientific and engineering data collections—minds full of information gathered as the result of the research of others, but without the interest or the training to make it the basis for investigation on their own part?

We need more college professors who do not merely impart a certain amount of scientific information to their students. We need teachers who themselves are investigators and who are a source of in-

spiration as well as purveyors of knowledge; who are not content to give their pupils merely the results of the attainments of scientists of the past, but who are themselves experimenting to learn new scientific truths, and who encourage their pupils to experiment. Such teachers are and should be relatively expensive for they are rare and complicated.

Would it not hold the interest of the boy in college in the work of his course if he could get his hands into real experimental work with a professor who was earning $25,000 a year on some pioneer work? If he assisted in experiments on alloys of magnesium with chromium, for example, and saw the promise of lightweight airplane metals or platinum substitutes, for example, might not even the trite burning of magnesium interest him? Might not helping in real investigation work convince him that he is on the right track so far as his education is concerned and that his best application to his college work is well worth while? If the importance of experimental work as the promising avenue to the successful completion of a worth-while quest were more strongly emphasized, might he not naturally come to value and to practice inquisitive patience?

Our colleges equip their graduates in science and engineering with a mass of technical information, which is certainly desirable. Without it, the most interested and ambitious research man feels mentally cramped. But they rarely leave them with even that natural inquisitiveness and general interest with which they first entered college.

The methodical accumulation of old facts by its apparent economy in teaching makes the student dread the greater expenditure necessary for production of new information. It is as though a halo surrounded ancient data for which attempts to produce new or different knowledge was anathema. Some such reason may account for the decrease in inquisitiveness discernible in maturing youngsters and the undue reverence for old truth. There is a difference between the acquisition of knowledge and its production. We may acquire more than any other country, but we produce relatively little of it yet.

We need more men of outstanding eminence in the scientific world in college professorships. How shall we get them? One thing that would help would be better salaries—salaries in keeping with the importance of the work. Another would be such an increase of the teaching force as to take more and more of the mere routine or executive work from the shoulders of the department head if he is a man fitted for research.

Might we not gain by so increasing the requirements of the scientific and engineering courses as to weed out aimless and ambitionless students, and thus lighten the task of the teacher? Would there not be a gain in the case of the smaller college, at least, if the number of students in such courses were limited to a definite maximum?

It is a great opportunity. It is because of successful labor in the field of research that today men ride in ease and comfort from New York to San Francisco in a few days instead of making a hazardous journey of months on foot or on horseback. The man in Duluth closes a business deal with an associate in San Antonio by speaking into a telephone transmitter, instead of making a long and wearisome trip. We may fly over land and sea at amazing speed in aerial vehicles, or we may ride beneath the surface of the waves. At a snap of a button the house is illuminated; at the throw of a switch the myriad machines of a great factory begin to turn. From the woman released from the thrall of the washboard by the washing machine, to the statesman who averts war by a radio message hurried across the sea, all are in debt to research, but we are poorly organized for this work.

Wonderful as the achievements of the last half century seem, the scientific terra incognita is by no means mapped. Indeed, we have not penterated very far into it. There are possibilities of wonderful discoveries there.

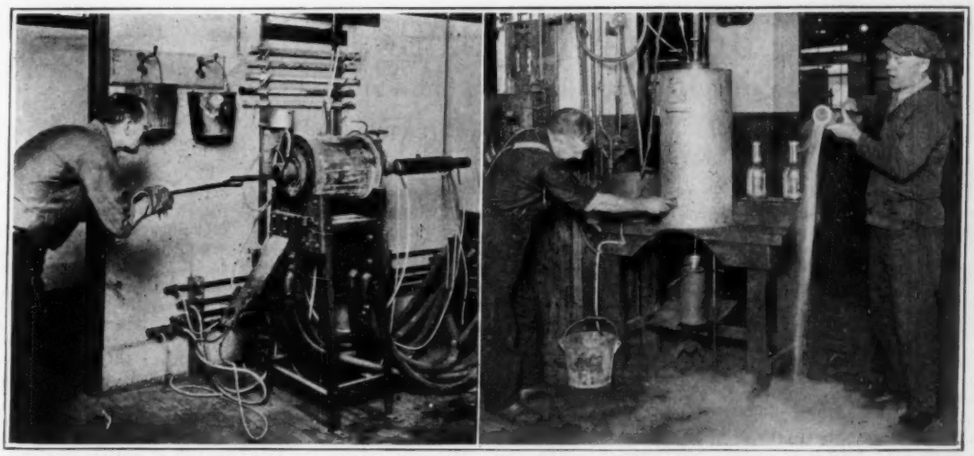
And it is work which promises something infinitely better than mere selfish gain—though there are, to be sure, personal rewards of a most satisfactory kind incident to it. It is a work of service to mankind for which most men have an impelling instinct.

In serving mankind, Americans will be serving their own people, not merely through making it possible for them to do more work, to do better work and to do it more easily, but by making them teachers of the rest of the world. Science applied to industry is creating new demands. It is resulting in calls for machinery never before built. Hence it is originating new fields of employment and new utilizations of raw material, with all that this means to industry and to the employment that runs parallel to industry.

Shall we not lead in this field, and to do so shall we not train men who will make such leadership possible? It is a great opportunity that presents itself to America—great in the possibilities it offers for advancing its own immediate interests, and for promoting the welfare of mankind.

In chemistry we are seeing today a wonderful illustration of the value of the policy of suitably supporting far sighted research, the simple acquiring of new knowledge. Our newspapers are full of discussion of the dye embargo. They find that our weakness in this chemical field bears very heavily on all parts of industrial interests. Fertilizers for the farmer and ammunition for the Army and Navy, benzol and new synthetic auto fuels, the thousand and one organic compounds used in medicine, war gases and an endless list of related materials hail from Germany. England, France, Japan and Italy have already shut out German dye stuffs. As the key to the situation, America must do likewise. This is advisable, not merely for the protection of the relatively small industry—artificial colors, but for the protection of the whole future of many lines of chemical industrial development.

How did Germany happen to occupy this powerful situation, from which the greatest war-failure ever suffered has not been sufficient to remove her? She had employed for years highly educated, pure research men working in, and teaching organic chemistry. This was before the first artificial coal tar color was produced, or any technical applications in sight. Every one of twenty Universities was the center of some branch of organic chemical research where an able man was making it his entire life-work to add to the knowledge of his branch. Lecturing was only a part, frequently a very minor part of his work. His students came to him because he was a great worker. They each spent a year or two (sometimes much more) working out some purely scientific non-commercial organic analysis or synthesis for its educational value. Many thousands of new compounds were thus made and their properties learned, published and cataloged. It had been found that substances once thought to be produced by life alone were producible in the laboratory, and that countless compounds never produced before could be synthesized. This opened an infinitely long vista to chemists. Looking back upon this policy of pure research, it seems very far sighted. In fact there is on the horizon no other tested method insuring the advancement of a country which compares at all with that of the combination of intelligent, inquisitive orderly searching, combined with teaching, whether it be for art or industry.



Left: The hottest spot in Schenectady: inserting a bar of metal into the molybdenum furnace at about 5000 degrees. *Right:* At the other end of the scale—liquid air at 320 degrees below (Fahrenheit)

Temperature extremes in the G.E. laboratory

America's First Model Airway

THE establishment of America's first model airway—linking the headquarters of the Air Service of the United States Army at Washington, D. C., with its engineering division at Dayton, Ohio—is considered the initial tangible effort to develop both commercial and military aeronautics in a national way. The proposed plans call for the location of landing fields, and the erection of hangars by the municipalities deriving benefits from the organized air navigation.

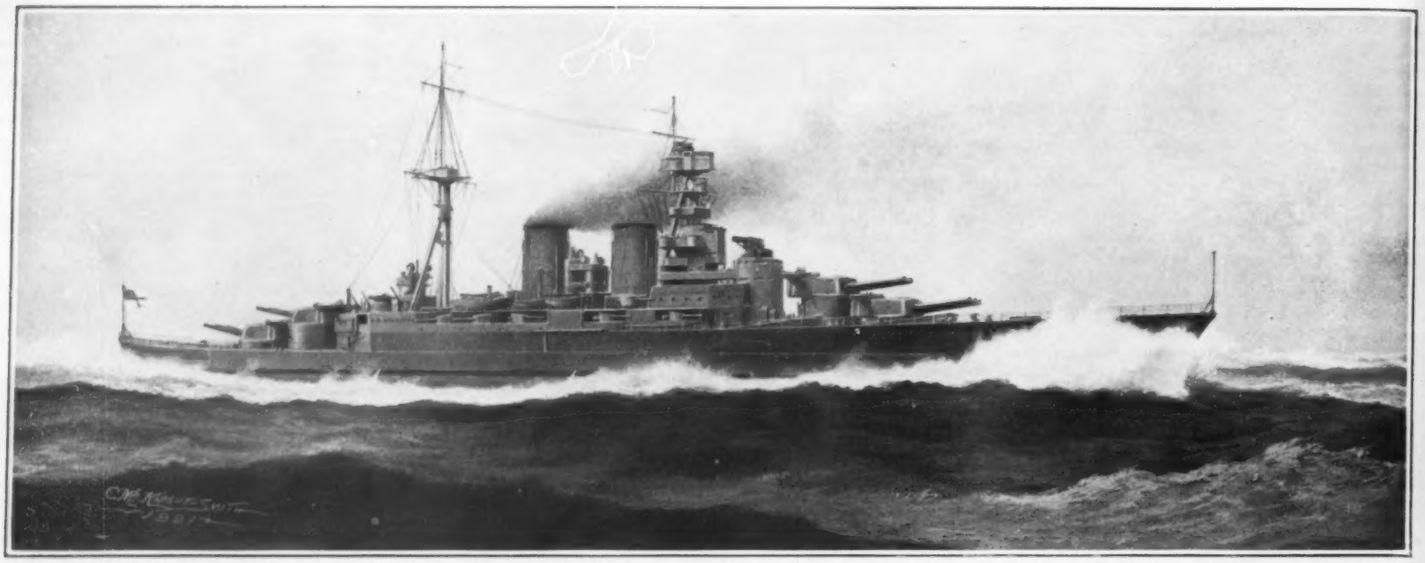
Ultimately, anticipating the success of the Washington-Dayton air-line, the country will be threaded with a network of well-defined routes for air-going machines. The units of the National Guard and the organized reserve will find these highways of the air a base for operations. The Air Service, however, disclaims any intention of usurping the system, but travel, under legislative restrictions, will be open to commercial aeronautic interests.

The Boy Scout organization has been enlisted as an agency to place markers as means of identifying the various towns over which the model airway will course. This youthful organization was instrumental in laying out the landing field identification at Bolling Field, Washington. The Chief of the Air Service in writing the mayor of Cameron, West Virginia, says: "In the first place it is necessary to have every town along the route of any size marked according to an international system so that the aviator going from one part of the country to the other will know at a glance, even without the aid of a map, his approximate locality on the earth's surface. The dimensions of this mark and instructions with regard to it will be found in the instructions to Chambers of Commerce and Boy Scout organizations attached herewith."

The first unit in the proposed systematic chain of airways for the entire country is typical of conditions that will be encountered elsewhere. Mountains are to be passed over, and the climatic conditions are variable. The Washington-Dayton line will serve as a basic guide for the contemplated expansion of military and commercial aviation. Cities and towns, favorably situated, are being urged to establish landing fields. If this is not feasible, then an emergency field is suggested for the reception of the aviator should he experience engine trouble or other aggravating circumstances, rendering it advisable to bring the machine to earth.

The Air Service of the United States Army is unable to purchase land or provide expenses incidental to the creation of the model airway, but can supply such equipment as is available for insuring the establishment of the route. The municipalities, civic organizations, and individuals will be necessarily taxed with the actual creation of the navigation route. Writing to a mayor in a nearby town, the Air Service says: "Attention is invited to the fact that Congress has not appropriated any money for the purchase of property for this purpose; and while, in some isolated cases, the Air Service may lease a field at a nominal sum to enable it to erect temporary structures and install a radio direction tower or station, it will not be advisable or necessary to own or lease all the possible fields. Natural landing places, such as pastures, could be kept in shape by Boy Scouts of the community and would be an exceedingly valuable asset to the Air Service if charted on our airways. Those towns and cities that provide these will always be kept in touch with the passing airplane traffic."

Cross-country flying and flying by night will be stimulated by a completion of the Washington-Dayton airline. Other than landing fields, the plans contemplate radio direction finding, wireless communication, aids to night navigation, housing and maintenance of equipment. Information and advice relative to landing fields, radio apparatus, hangars, and other specifications incident to the creation of the airway will be supplied by the Army Air Service. This service may include the detailing of a qualified officer to superintend the work.—*By S. R. Winters.*



Great Britain has authorized the construction of four battle cruisers, whose general design is shown in the above illustration. They will be similar in appearance to the "Hood," from which they will differ in having a more powerful armament and heavier and more complete armor, at the cost of lower speed. They will mount ten 16-inch guns and will have a sea speed of about 29 knots

Britain's New Battle Cruisers

Some Particulars of the Four Big Ships of the British Program

By Hector C. Bywater

EARLY in September the Admiralty invited bids for the construction of the first four capital ships which have been authorized for the British Navy since 1916. They are officially described as "replace" ships, and before they are placed in commission at least eight of the older dreadnoughts will have gone to the junk heap. It is understood that tenders for the hulls, machinery, and equipment of the new ships have already been submitted by the leading shipbuilding firms, and an early announcement as to the allocation of the contracts is expected. In former times it was the custom to allot one big ship of each year's program to the Royal dockyards at Portsmouth and Devonport, respectively, but this was impossible in the present instance because the building slips at these yards are not large enough to take vessels of such colossal dimensions as those of the post-war capital ship. Consequently, all four units are to be built by contract, and in view of the uncertain state of the labor market and the fluctuating price of materials it is not improbable that the work will be done on a cost-plus-profit basis.

Battle Cruisers with Heavy Armor

Up to the present only the meagerest details of the new ships have been published officially, and the Admiralty shows no inclination to disclose further particulars. But from hints dropped in the House of Commons during the recent debate on the Navy Estimates and from various statements made in well-informed quarters it is possible to visualize the essential features of the design. Although they are officially designated battle cruisers, the new ships will be slower than the "Hood;" but they will have thicker armor and a much more powerful battery. They may therefore be taken as representing a virtual amalgamation of the battleship and battle cruiser types, a course which has been strongly urged by British naval officers with war experience.

The striking lessons of the late war have, indeed, profoundly modified the British estimate of tactical values. Ten years ago there was a veritable craze for speed, and in order to gain an extra knot or two hitting power and protection, but especially the latter, were cheerfully sacrificed. Several of the British battle cruisers with the Grand Fleet carried thinner armor plating than that of the German pre-dreadnoughts, and their sides were penetrable by heavy-caliber shell at almost any effective range. Furthermore, weight had been saved by thinning down the armor on turrets and barbettes, and by fitting horizontal protection that could offer no serious resistance to heavy blows.

Ten-Minute Ships

Even before the war the vulnerability of these ships was well known in Germany. Admiral von Tirpitz dubbed the "Invincible" class "Fisher's ten-minute ships," thereby implying that they would succumb to attack by gunfire in ten minutes. Jutland unhappily vindicated the accuracy of this German estimate. The *décuirassement* doctrine, initiated by Lord Fisher, found its most striking expression in the battle cruisers "Renown" and "Repulse," built during the war. These ships were fitted with narrow belts of 6-inch armor, and when they joined the Grand Fleet at Scapa Flow Admiral Jellicoe, realizing their fatal weakness, refused to incorporate them in his battle formations until they had been taken back to dockyard and fitted with thicker plating over vital parts. Since the war the "Repulse" has been partly reconstructed, and in place of her original belt now has a deep girdle of 9-inch armor. Also, the anti-torpedo bulge has been broadened and deepened—changes which have increased her fighting efficiency by 50 per cent. Her sister, the "Renown," will undergo a refit on similar lines when opportunity offers.

Improving on the "Hood"

In the "Hood," which was designed before the Battle of Jutland, but not actually laid down till afterwards, an attempt was made to embody the lessons of that action by increasing the armor belt from 8 to 12 inches and the barbettes from 9 to 12 inches, involving an additional weight of nearly 5000 tons. But the "Hood," after all, was a compromise, and has been explicitly repudiated by the Naval Staff as a genuine post-Jutland type. They consider her design to be wasteful in that it allows a battery of only eight big guns on the enormous displacement, at full load, of 44,600 tons, and they are not satisfied with her protection against flat trajectory and high-angle fire. All these faults are to be remedied in the new ships, the plans of which have probably received more attention than was bestowed on those of any previous unit of the Royal Navy. Briefly stated, their salient characteristics are: a numerous battery of 16-inch guns in triple turrets, side armor proof against perforation at long range, and very stout horizontal protection; moderate battle cruiser speed, but a very extensive cruising radius; duplication of controls for every important element of the maneuvering, gunnery, torpedo, and signalling organization. The following data, not being official, must be accepted under reserve, but they are believed to be substantially accurate: Length over all, 850 ft.; extreme breadth, 104½ ft.; mean draft, 29 ft.; normal displacement, 43,500 tons. How many 16-inch guns will be mounted is not definitely known, but alternative arrangements of ten guns in two triple and two double turrets, and twelve guns in four triple turrets, have been suggested. The machinery will be geared turbines supplied by small-tube boilers, the plant developing up to 125,000 shaft horse-power. According to this figure the maximum speed will probably be about 29 knots. The proposal to equip one ship with the electric drive has been rejected, as this method of propulsion is not viewed with favor by British naval engineers. The machinery will account for about 9.5 per cent of the total displacement, as against 13 per cent in the "Hood." This fact is significant of the diminished value now attached to speed by the controllers of the British Navy. The oil stowage capacity will be sufficient for a run of 10,000 nautical miles at economical speed, enabling the ships to steam from England to Hong Kong without refuelling. No details of the armor system are accessible, but it is known that valuable pointers were obtained from the firing experiments at the ex-German battleship "Baden" last March and from several other tests conducted in the past twelve months.

Why the 18-Inch Gun Was Rejected

From the gunnery viewpoint the most interesting feature of the new ships is the introduction of the 16-inch caliber, which is new to the British Navy. Some thirty years ago a 110-ton piece of 16¼-inch caliber was mounted in a few ships, but was eventually discarded on account of its abnormal weight and slow rate of fire. Why the 16-inch gun should have been adopted at this stage is something of a mystery to the uninitiated, considering that the new mark of 15-inch mounted in the "Hood" has proved to be a thoroughly satisfactory weapon. But the explanation is simple enough. The Naval Staff, presided over by the First Sea Lord, Earl Beatty, is said to have been in favor of mounting 18-inch guns in the new battle cruisers. Guns of this caliber were actually made during the war and displayed magnificent ballistic qualities both on the proving ground and in action against the German positions on the Belgian coast. The monitor "Lord Clive," armed with a single 18-inch gun, made accurate shooting at 42,000 yards, and on the eve of the armistice this vessel, together with another monitor similarly armed, was preparing to bombard Bruges at a range of 50,000 yards. All who have seen the 18-inch gun at work are in agreement as to its fine properties. Notwithstanding its great weight—160 tons—it can discharge one round per minute, and its accuracy at all ranges is far superior to that of smaller caliber

(Concluded on page 158)

Railways of the World

Comparison of the Mileage, Equipment, Working Force and Total Investment of the Eight Leading Railroad Systems

THE upheaval of the world war wrought havoc—in the case of Russia, deadly havoc—with the railroad systems of the world. The mischief done was both material and economic. The material damage was due both to abuse and neglect. The railroads were abused inasmuch as they were greatly overworked and were operated very largely by unskilled hands; they were neglected because the men who should have attended to the maintenance of the track and the repairs of the rolling stock were fighting on the various fronts. Even had skilled forces been available for this work, funds for proper maintenance were not available; for they were in too great demand for the manufacture of war material and for meeting the insatiable demands of the Commissariat.

On the economic side, the damage and loss suffered by the railroads was as great, if indeed it was not greater, than on the material side. For the neglect of the roads in war time must be made good during the peace that follows. Unless a railroad is kept up to a certain level of excellence, its further deterioration will be rapid and inevitable. Therefore, the money which has been diverted during war time from necessary repairs, upkeep and improvements must be made good to the railroads and this money must be spent with a lavish hand and with the least possible delay, if the damage is not to become permanent and rapidly progressive.

The American public has learned all these facts at first hand; and they have been told by their most able railroad experts, men whose word they have learned to take at its face value, that it will require some billions of dollars to make the needed repairs and bring our great railroad system, with its 256,572 miles of track, up to standard efficiency. And what is true of our railroad system is true in even greater degree of those of Europe, where the damage by war, the lack of skilled workmen, and, above all, the want of adequate funds for operation and upkeep, have worked with even more disastrous effect. In one country, Russia, which, by the way, possessed before the war the largest total mileage of any European country, the blighting hand of Bolshevism has fallen with tragic consequences. All the reliable evidence that has come out of Russia seems to prove that her railroad system is practically wrecked.

Another burden that lies with crushing effect upon the railroad systems, including that of the United States, is the abnormal increase which has taken place in the pay of the employees. Advantage was taken by the unions of the urgency created by the war to push the pay of railroad employees up to a level far beyond the point at which labor can secure comfortable living conditions, and also far beyond the point at which the railroads can be profitably operated or kept in good condition.

Difficult to Obtain Reliable Railroad Statistics

It will be understood that the ravages of the war and the uncertainties of the post-war conditions render it a difficult task to obtain accurate statistics of the railroads for the past year; but painstaking work has been done both by the Bureau of Railway Economics and by the Bureau of Railway News and Statistics. We publish herewith a table for which we are indebted to the last-named Bureau, which embodies the latest official information received in this country. Naturally, nothing up-to-date has been obtainable from France or Germany since 1914, and the figures for Russia date back to 1910. Both France and Germany have been actively restoring their railroads, and the reconstruction of destroyed lines in the devastated regions of northern France must by this time be very nearly complete. With regard to Russia, the reader must be content to take the 1910 statistics and draw his own conclusions as to present conditions. The figures for Great Britain are reliable; those for India up-to-date; and the Canadian statistics are thoroughly reliable.

The United States

The total mileage of the United States, 256,752, is greater by some 35,000 miles than the combined mileage of the seven other countries that are given in the accompanying table. The total mileage of thirty of the leading countries of the world, including the United States, is estimated by the Bureau of Railway Economics to have been in 1916 about 640,000 miles; and it is probable that the total railway mileage in all the world is about 720,000.

In comparing our statistics with those of the seven other countries shown in the table, certain facts should be borne in mind and applied to the figures given if we are to appreciate them at their real value. For instance, our locomotives are generally twice, and in many cases three times as powerful as those of any other country given, except Canada; and consequently, in respect to hauling power, the figure of 68,592 should be rather 150,000 in comparison with Great Britain, France or Germany. The same thing is true of passenger cars and freight cars, the former probably averaging from 50 to 100 per cent larger than the average passenger car in European countries, and the capacity of our freight cars being three times that of the freight cars of other countries, with the exception of India and Canada. By applying these percentages, our totals for rolling stock will be brought up to a closer proportion to our total mileage of track.

Passengers Carried

In the number of passengers carried, our total of 1,253,396,000 carried on 256,572 miles of track looks low as compared with over a billion and a half carried on 23,724 miles in Great Britain, and 1,797,188,000 carried on 38,866 miles in Germany. This discrepancy is explained by the greater density of the population in those countries, the much shorter distance travelled per passenger per trip, and the very heavy workmen's traffic on steam railroads in European countries. Moreover, the average distance travelled per trip is longer in America than in any of the countries of Europe.

Freight Traffic

Perhaps the most impressive figure, next to our total mileage, is the total number of tons of freight carried per year, which reaches the stupendous figure of 2,305,190,000 tons. The next largest total is for Germany, whose roads carried 624,067,000 tons, and for Great Britain, whose total was 317,877,000 tons. The lowest figure, which is 41,099,000 tons for Italy, shows how that country is wanting in ore, coal and other bulk shipments which serve to swell the totals in great industrial countries like our own, Great Britain and Germany.

Huge Capital Investment

After all, it must be admitted that the most impressive totals are those showing the amount of invested capital for the various roads, which in the case of the United States reaches the stupendous sum of about twenty-one billion dollars. This is approximately equal to our actual expenditure during the war. Another scale of comparison is found in our great war shipbuilding venture, the cost of which is now put down at about three and a half billion dollars; a vast sum, in very truth, but only one-sixth as large as the capital invested in our railroad systems.

RAILWAYS OF THE WORLD COMPARED

	United States	*Great Britain*	*France*	*Germany*
Mileage	256,572	23,724	25,378	38,866
Locomotives	68,592	24,162	14,344	35,025
Passenger cars	56,290	54,853	31,824	86,873
Freight cars	2,456,607	781,518	370,806	692,053
Investment (T)	$20,987,921	$6,531,751	$3,895,484	$5,045,641
Employes	2,072,971	763,359	459,308	820,461
Passengers carried (T)	1,253,396	1,566,834	541,342	1,797,188
Frt. carried—tons (T)	2,305,190	317,877	208,018	624,067

	Italy (a)	*Russia*	*India*	*Canada*
Mileage	8,953	48,426	36,735	39,196
Locomotives	5,220	19,984	9,068	5,756
Passenger cars	10,024	20,043	24,704	6,376
Freight cars	103,117	450,273	196,747	209,243
Investment (T)	$1,334,928	$3,508,675	$1,854,340	$2,615,102
Employes	154,856	771,938	711,690	184,934
Passengers carried (T)	82,402	195,017	533,180	51,306
Frt. carried—tons (T)	41,099	258,339	87,630	127,388

(T) Thousands.
(a) State roads only.

The American Car in the Argentine Market

THE American automobile gained its great impetus during the war. Two or three makes of low-priced cars covered the country so well that the United States became known as a great producer of automobiles. In 1918 the agents of an American low-priced car began importing them knocked down, thus eliminating part of the customs tariff. During 1919 about 12,000 of this type were brought in, and in 1920 their sales reached 16,000. A shipment of 1,500 monthly was then commenced, but was not sufficient to meet the demand.

The spring sales began in August and September with large demands for all makes of cars, and most of the agents were looking forward to increasing their monthly contracts when the crisis was reached in late September. Buyers from that time on seemed to be in a panic and there was a great reluctance to purchase new cars. A general reduction in prices on all commodities was looked for in the United States which would also include the prices of automobiles and which was strengthened by daily cables of falling prices received from the United States. Moreover, it was felt that dollar exchange, which had begun to rise rapidly in September, would fall again when the summer crops began to move. Statistics, however, were not available to show the unfavorable trade balance with the United States which existed during the first half of 1920, and the true cause of the rise in exchange was not generally known. The summer, normally the selling season for automobiles, therefore passed with comparatively few sales, and the automobiles en route or on contract were left in the custom house at Buenos Aires on arrival. By the end of the summer there were 3,500 cars in the Buenos Aires custom house. An increase was avoided, however, by many of the manufacturers agreeing to cancel contracts or stop shipments. On April 5 the stocks were reduced to about 2,300 cars, in addition to about 2,500 knocked-down cheap cars.

Although during the summer of 1919-20, due to the prosperity in the live-stock and agricultural industries, sales of automobiles were heavy, nevertheless during the summer season just passed there has been practically no selling in this line. One agent reported that he was disposing of from 20 to 50 cars monthly, as compared with 100 per month previously, while another had sold only two cars in April and none in the two months previous. The agent of an expensive American car claimed that by placing his price at the maximum the trade would stand (25,000 pesos) there was little profit, due mainly to the high rate of exchange.

Every year there is a marked improvement in the roads of the Republic, and the Argentine cities, almost without exception, have very good pavements. Under normal commercial conditions, therefore, there should continue to be a growing demand for automobiles of all classes, especially with the cheapening of gasoline by the development of the oil resources of the Republic. The present stagnation cannot be much improved, however, until there is a normal rate of exchange and until there is a great movement of Argentine pastoral and agricultural products. In the meantime the agents of American firms feel that it is a mistake to stop advertising, although they do feel that the expense should be borne partly by the manufacturers. There is, moreover, every reason to believe that the demand for automobiles will continue to grow after the present depression is over, and that Argentina will easily require each year, for some years to come, upward of 10,000 automobiles of the better class. The largest part of the business can be kept in American hands if the manufacturers will cooperate with the dealers and continue a strong representation in the field.

Science in Safe-Breaking

How Modern Technology Works For and Against the Yeggman

By Roy A. Giles

WAR between nations ends. Disarmament is discussed if not accomplished. The contest between the makers of armor plate and projectiles lags at times, and swords are laid aside, pro tem, even if they are not hammered into ploughshares.

With the planners of safes and vaults, and the safe, vault and bank robbers, however, things are different. Theirs is a war that knows no armistice. One seeks constructively to erect an immovable object. The other plans with merciless science and ingenuity to propel an irresistible, destructive force, which is an old comparison, but an apt one.

Allies on the constructive side of this perpetual argument are the police forces, which include some wonderfully efficient private agency men. The police might be likened to the heavy artillery or "suicide club," in the battle. They wage a relentless war night and day and the list is long of those who have given their lives to the cause.

Some writers delight to picture crooks as lovable, adventurous characters who, by their wit, make laughing stocks of policemen. These writers make crime attractive, and by suggestion keep creating new crooks. The crook in real life, regardless of his particular line of criminal endeavor, is anything but pleasing. A crook is a lower animal who lives a parasitic life. He attacks you, like a mosquito, at night. He steals your chickens like a skunk. He takes advantage of your womenfolks like a savage, and he hides in dark places and prowls around at night like a rat.

Running down the scale of crooks, we find at the bottom, the cracksmen, who are known in the parlance of the underworld as the "yeggs." They gave the name to themselves. The word yegg or yeggman originated among the Gypsies and was used to describe a particularly clever crook in the band.

Of all crooks the yeggs are the most brutal, merciless, murderous and cruel. They have been known to commit murder without provocation. They have resorted to torture to locate treasure and have battled a whole countryside in a "get away," shooting men, women and children indiscriminately.

Yeggs are nomadic and migratory. They move in packs or "mobs" of from five to ten members under a leader or "highmobsman." Like all crooks, they drop their real name for a "moniker" or nickname. They take these names from a physical peculiarity, usually, and attach the name of the town, in which they went "on the gun" or became a thief. A fat yegg from Omaha would become "Omaha Fatty," a thin man from Cincinnati became "Cincy Slim," a red haired man from Denver is known as "Denver Pink, the bundle bum," because when he first started out he used to carry one clean shirt, as he liked a change now and then. He later became less fastidious about his toilet. "Goat Hinch" was the leader of a notorious band of yeggs and "Tea" was his right hand bower. "Tea" was called Tea because he steeped tea at the "smudge" or camp fire while the others brewed "java" or coffee. The yeggs have a language all their own. Punk is bread. Soup is nitroglycerine. Jail is jug, prison is stir, a gun is a rod, a freight train a rattler, a safe is a gopher. To snuff a gopher means to blow a safe. To jump bail is to lam, and so on.

To thwart these thieves, who are as crafty as they are cruel, the vault builders have evolved secret processes for toughening and hardening steel, they have invented time-lock mechanisms, burglar alarms, trap guns and have erected vaults, the doors of which, alone, weigh several tons. These larger safes, used in the big city banks are invulnerable to yeggs; but, undaunted, the yeggs go merrily on snuffing the little gophers and ripping and smashing, destroying and stealing.

Inspector John Coughlin, chief of detectives of the New York headquarters staff, says of the yegg:

"The yegg burglar is distinct among criminals regarding mode of operation and method of living. The most sought recruits among these fellows are machinists or mechanics who lose their employment and drift, finally meeting some professional yegg who recognizes the value of the recruit in his knowledge of handling tools and explosives.

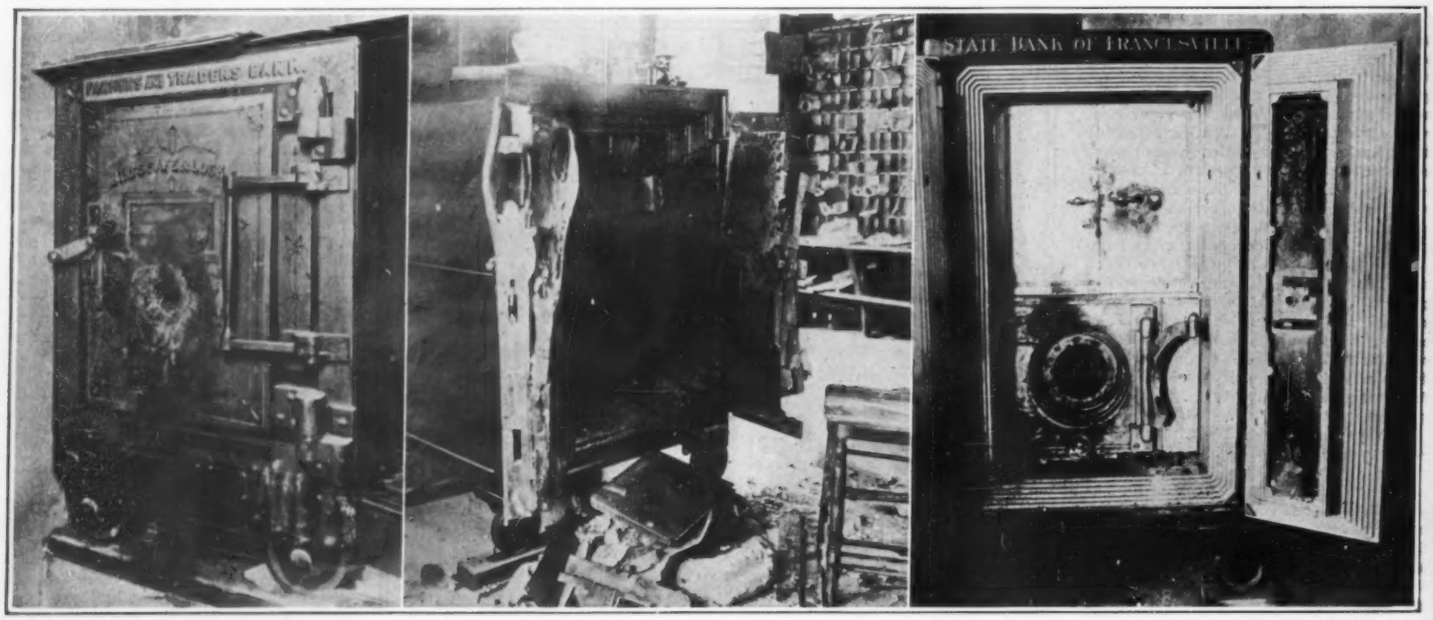
"These men drift away from relatives and have no responsibilities. They make money easily and spend it lavishly. In some instances they make as much on one 'job' as they could earn all their lives at a trade. Their homes are cheap rooming houses and their hang-outs cheap saloons usually conducted by former yeggs.

"The yegg has his attention drawn to the small town without adequate police protection. His intent is to rob a postoffice or bank. He hopes in case of arrest to escape from the small town jail which is insecure in most instances. They resist arrest, however, and try to shoot their way out of town if discovered in action. It is general practice to have a receiver of stolen goods dispose of loot on a percentage basis. This person attends to furnishing bonds and employing 'mouthpieces' or lawyers, in case of arrest.

"One of the band visits a town carrying postcards and poses as a vendor. He makes observations as a 'finder,' locating the place to be robbed and mapping the lay of the land and the 'get away.' He reports to the chief yegg. They usually 'hit' the town by breaking into a garage and stealing an automobile. They arrive in town well after midnight. Two remain outside as 'stalls' or lookouts, the rest enter as 'blowers.' The inside men blow the safe with nitroglycerine obtained by boiling down dynamite stolen from contractors along railroads or near coal mines."

It would seem that bank and postoffice safe-blowing would be a game that would hardly attract women, yet in these days of equal rights and vices there are women yeggs. To cite two cases:

In the Merchants Bank at Kansas City, Mo., there is deposited $500 reward for the arrest of Mattie Howard, who jumped her bail, or "lammed." Mattie is also known as Mrs. Frank Vanders. She is 28 years old and pretty. She is physically perfect and seemingly mentally acute. She dresses well and makes a good appearance. She has been a yegg, police records show, since she was a young girl. She has worked as a telephone operator, as a blind to her real profession. Her first arrest was when she was 23 years old. A Kansas City police department circular, asking for Mattie dead or alive, reads in part as follows:



Left: This safe offered unusual resistance to the acetylene torch, but was robbed just the same by burning a hole around the combination knob. *Center:* A safe of the common "gopher" type blown with nitroglycerine; a post-office job. *Right:* A "combination" job, calling for the use of nitroglycerine to blow off the outer door and of the acetylene torch to open the inner chamber

Some results when modern technology is impressed in aid of the safe-blower

"She will be found with bank robbers, postoffice robbers and smugglers. Often goes out on the job dressed as a man and may be now disguised as such. She is a leader and planner of the most dangerous type. May now have her hair auburn or any other color. Natural color is dark blonde. Born, Preston, Idaho. May work as telephone operator. Care should be taken in making arrest, as she would not hesitate to commit murder at any time."

Margaret Brooks, wife of Harry Brooks, is suspected of yegg activities. She and her husband are both held in Pittsburgh on a charge of murder, in connection with the killing and robbing of a messenger for Boggs & Buehl, a department store. This job netted the perpetrators $48,000.

Police departments and the manufacturers of safes and vaults object to detailed descriptions of mechanisms and manufacturers' processes being printed in mediums of general circulation. It can be said, however, that in the time of the early yeggs, before the automobile days, when railroad handcars were often the means of getaways, an ordinary drill would bore a hole in a safe. There are safes now which will turn a drill bit. When the acetylene torch was brought into general use the yegg promptly adopted it as accompanying illustra-

tions will show. What has been accomplished by the builders in resisting this torch is shown in the following case:

September 27, 1921, loft of S. Kaplan & Company, New York. The outer door of the safe blown open with nitroglycerine. Torch was used on inner door, made of a new process "fireproof" steel. This door successfully resisted all efforts of the cracksmen, the torch failing to affect it materially. The yeggs failed to get $200,000 in money and securities which the safe contained. Three safes in the lofts of E. J. Bass, silversmiths, 618 Broadway, New York City, recently resisted acetylene torches in similar fashion.

The best products of the safe builder's art are the massive vaults in the big banking institutions. These are of steel and concrete construction, with ponderous doors hung on a balance which permits their opening and closing by no more effort than can be exerted by a small child. They are protected by intricate time-lock devices and burglar alarms. The yegg is yet to live who can even make an impression on these vaults. They have never even tried to any extent; most of these vaults remain unmolested. The yegg realizes that he cannot hope even to get near these safes, and could he get near them his efforts would be futile. In these safes his force has met an immovable object.

Often in the cases of ordinary commercial safes, even the larger kind, the strong boxes have been known to yield to a sledge hammer in the hands of what might be termed a "fancy sledge swinger." The combination knobs have been knocked off with the hammer and the tumblers of the lock worked through the small hole, where the knob had been.

The thinner sheets of steel used on the backs of some safes have yielded to a device known as the "can opener" pictured in the accompanying illustration. This is fashioned from a crowbar or wagon axle, and given a specially tempered and processed point and cutting edge. This device is never used by a yegg, but a class of cracksmen has sprung up who make use of it. It has ripped sheet steel, just as a can opener rips the top of a sardine box.

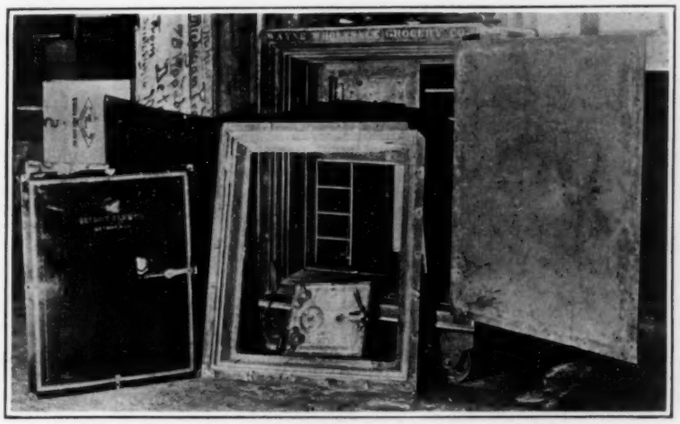
A joke in the safe business is a small safe in Wichita, Kansas, won by its owner as a prize for tobacco coupons. This safe, because of a defect in construction which allows the force of an explosion to blow out, as a charge would blow out of the muzzle of a gun, has resisted four nitroglycerine explosions in the last 19 years. It has been hammered and banged and bungled about, but no yegg has ever opened it. It would not resist acetylene gas, however. If anyone ever turns a torch on that safe, it will probably melt and run out under the crack of the door. The material of which it is constructed is so malleable as to be almost plastic.

Writers of lurid fiction and drama love to tell of the "Alias-Jimmy-Valentine" type of cracksman, who works on strong boxes with no tools but his lily-white hands. He is supposed to be able to work the combinations of safes by sense of touch and hearing. In the pictures he is seen sand-papering his fingers to make the nerve ends acutely exposed. Few of these men exist. Ten weeks ago a certain authority believed that none of them existed. But they do exist, and here is the proof:

June 22, 1921, three combinations on three different safes in the offices of the Sinclair Oil Company, tenth floor of a big office building were worked either by sense of touch or hearing. No finger prints or other clews were found. The job netted the perpetrator, and it is believed there was but one man on this job, $200,000, in stocks, bonds and money. To reach the safes this man had to pick the lock at the street door, elude watchmen and scrub women, make his way to the tenth floor and pick the locks on doors into and between offices, four doors in all. Besides opening the safes, this prowler picked the locks on several desks for good measure.

The combinations of these safes were not all known to any one man. Three clerks knew one combination each. The combinations were not in any of the desks robbed. Every indication points to one fact, and that is that the cracksman either felt or listened his way into those three safes, during some period of time between Saturday night and Monday morning. He worked either with gloved fingers, or had painted his finger lines out with collodion. In the annals of crime this successful triple safe job stands out as the cleverest ever recorded.

The "can-opener." This tool rips strong steel plates just as the familiar kitchen implement opens the sardine box. The attack is made at the rear of the strong-box



The effects of a nitroglycerine explosion on a triple-plate steel safe

A peculiar misunderstanding resulted in the accounts of this masterful safe robbery effort finding its way into the newspapers. It had been intended that the case should not be given publicity, because, having been unusually successful, its being published would tend to suggest further crimes along the same line, or at least further attempts, for few men live who could duplicate it.

But—a reporter was browsing around the Old Slip police station. He heard two detectives talking and went back and wrote the story. Through a mistake, the source of the information was given as the Pinkerton National Detective Agency, which has never been known to give out newspaper information in the many years it has been in operation. The last thing in the world this agency would have discussed with a reporter was this particular robbery. However, the reporter had it, and through a general spilling of the beans the agency got tangled in the publicity.

Our friend the Inspector has said that yeggs often make as much on one safe robbery as they could earn in a lifetime at their trade. BUT—when they are out of jail—which is seldom, for most yeggs spend most of their lives in penitentiaries at hard labor—they endure hardships that few men would care to wish upon themselves. Drinking alcohol out of a tin cup, or taking drugs to steady their nerves, they live between jobs and arrests, hunted, haunted and hounded. Carrying nitroglycerine in a rubber bottle around their neck, or more carelessly handling dynamite and the deadly "soup," they are always in danger of meeting a swift and rather a scattered death, even if they escape being perforated by a police sniper or watchman. The record of "Michigan Shorty"—a sour-faced, open-shirted artist—should deter all who might have ambitions to go a-yegging. The record follows, abstracted from the New York **police file:**

Number of picture in gallery, B-41639. Name, Thomas Murray. Alias, Michigan Shorty, John Mack, etc.

Criminal record (as far as known)—1898, Allegheny Co., New York, receiving stolen goods; Elmira Reformatory.

1909, Broome Co., New York, 59 days, County Jail.

1909, March 26, Fillmore, N. Y., post office burglary; 5 years, Atlanta Penitentiary.

1915, burglary, post office, Snake Hill, N. J.; penitentiary, one year.

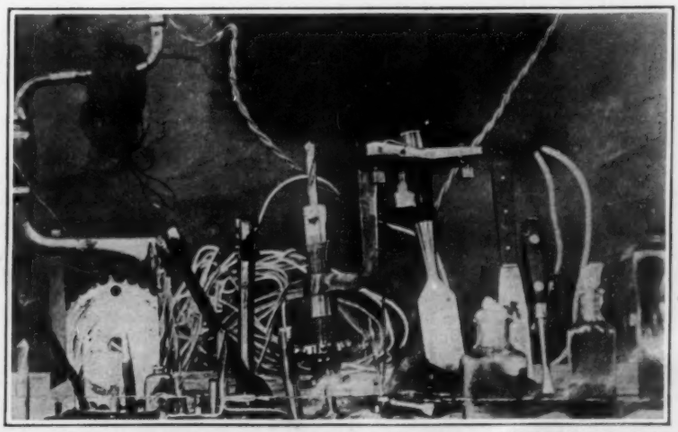
1915, February, Wilkes-Barre, Pa., suspect; no disposition.

1915, April 15, Philadelphia, Pa., suspect; discharged.

1916, April 6, as Thomas Murray, New York City, burglary; discharged, Magistrate Breen, Police Court.

1920, June 1, as John Murray, New York City, safe burglary (fugitive); delivered to the Federal authorities, June 10, 1920; no final disposition of case.

All in all, the yeggman's lot is not a very happy one, and the thrills and excitement are of a very low order indeed. The risks taken by the yeggman are so great, and the chances of making a real "haul" so slim, as to make the game a poor one at best.



A complete outfit for the "yegg" job of opening a safe without the use of the acetylene torch. The set comprises one brace, one drill, one wrench, one wood-chisel, one putty-knife, one screw-driver, one punch, three drill-bits, one oil-can, electric wire, rope, and two bottles of "soup" (nitroglycerine)

Wire Rope Fractures

THE mathematical principles involved in the examination of the strength of steel ropes and the fracture of wire ropes open up questions regarding which no general agreement has yet been obtained. Dr. E. M. Horsburgh has made a new contribution to this subject, and touched on some controversial questions.

The experimental work was carried out at the research laboratory of Messrs. Brunton, Musselburgh. The usual method of determining the forces is by resolving them both vertically and horizontally by the usual statical method. This method, it is asserted, is based on an incorrect hypothesis. The effect of combined stress was considered experimentally and theoretically in the paper. With regard to the modulus of elasticity of the rope, the author pointed out that this has been confused with Young's modulus. The stress strain curve of a rope, in contrast with that of a structural member, can be represented by a single function of one variable, and the gradient of this function is the rope modulus. An analytical expression was given, and the fitting of this to the data was discussed. Finally the author dealt with the wires of steel haulage ropes in actual use.

This work should prove a valuable contribution at a time when we are testing all manner of things to preclude accidents.

"Alabama" attacked by a 2000-pound demolition bomb. Shows the ship as seen from the air. Note the splash of fragments over wide area

The "Alabama" as she appeared after being shattered and sunk by army fliers. The blowing in of the hull below water is matched by this frightful wreckage of decks, masts and smoke-stacks above water

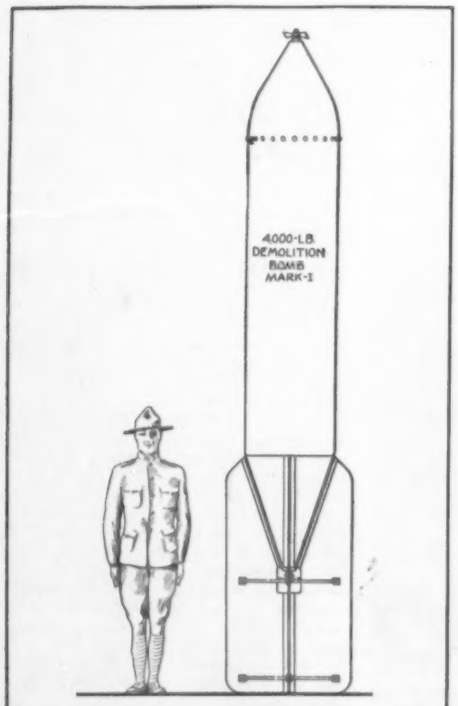
The 4000-Pound Demolition Bomb

A Means for Detonating 2000 Pounds of T.N.T. on a Selected Target

By Major William A. Borden, U. S. A.
Chief, Aircraft Armament Division,
Office of the Chief of Ordnance

A FOUR-THOUSAND-POUND demolition bomb, the largest bomb so far produced in the world, was recently tested by the Army Ordnance Department, at Aberdeen Proving Ground. This bomb represents the latest development in a systematic program which is being followed by the Ordnance Department in the preparation of armament for aircraft, and is believed to be the most powerful and efficient weapon of its type produced by any country.

When bombs were first used with aircraft they were comparatively small, but with experience in testing and use many types have been developed until they now differ widely in construction and vary in weight from a few ounces to several thousand pounds. During the war the largest bomb manufactured in this country weighed 1100 pounds, and some produced abroad weighed as much as 2000 pounds. Shortly after the signing of the Armistice a careful study was made of bombs by a board of officers appointed by the War Department, and as a result a program was prepared which covered the development of all types of bombs, some to be even larger than those used during the war.



A six-foot soldier and a 4000-pound demolition bomb, drawn to same scale

For several years the Ordnance Department has been engaged in perfecting the designs of the smaller bombs and until the present year no work was undertaken on bombs larger in size than those weighing 1100 pounds. During this time all bombs obtained from British, French and German sources during the war were studied and tested.

When it became known that extensive bombing tests were to be held with the ex-German ships, turned over to this country, it was appreciated that these tests would afford a great opportunity to obtain information as to the value of large demolition bombs. As a result the development of a 2000-pound bomb was immediately started, and in a few months the production of several of this type, for use in the bombing maneuvers, was completed. These were used against the ex-German ships and the ex-U.S.S. "Alabama" with highly satisfactory results from a bomb-design standpoint, but since it was realized that bombs even larger might be required to destroy the largest naval targets or demolish land targets, such as great munition factories, sea-coast gun emplacements, railroad terminals and storage depots, it was decided to extend the development program already outlined to include the design of a 4000-pound bomb.

Of all bombs, those of the demolition type have the widest field of application and are therefore of great military importance. They carry a large amount of high explosive, the charge being from 50 to 60 per cent of the total weight of the bomb, and when they strike, a terrific blast is produced by the detonation of the charge, which, within its destructive range, causes tremendous damage.

Demolition bombs are used in attacking manufacturing plants of all types, storehouses, ammunition dumps, railroads, railroad terminals, docks, locks, naval vessels of all types and similar material targets. In bombing any of these objectives that size of bomb is used which will insure, if possible, not partial but complete destruction of the target.

To the average person, bombs are merely large cannonballs filled with some sort of explosive, but to those engaged in their design they are very complicated mechanisms which must fulfil certain very definite requirements.

In designing a demolition bomb the main object is to produce a bomb body which will hold the greatest possible amount of high explosive and yet be strong enough to withstand impact with a target, or even to penetrate it. When a factory is attacked the maximum amount of damage is produced if the bomb penetrates the roof and floors of the building and functions only after it has reached the ground floor or basement, for then the force of the detonation fairly bursts the building apart. Of course, a bomb of this type will not penetrate heavy armor, but must be so designed that it will pass through the roof and floors of the ordinary factory or warehouse.

These bombs must be equipped with two fuses, one in the nose and the other in the tail, so that if one fails the other will function. Under certain conditions the fuses must be furnished with delay elements so that on impact the bomb will have time to penetrate before it functions, as, for instance, in the case of an attack against a manufacturing plant. Where only surface destruction is desired the fuses should be set for instantaneous action upon impact. For example, when a city is attacked and the bomb strikes in a street, it should function instantaneously, so that the force of the detonation will not be absorbed in the formation of a crater but will be directed as a blast against the walls of the adjacent buildings. Also, for surface effect, fragments of the bomb case are particularly effective, but if the action of the fuse permit a delay, the bomb will bury itself, and when it functions a large number of fragments will be caught in the crater and be ineffective.

In attacking naval targets the most effective results are obtained when the bomb strikes close alongside a ship and the fuse delays the detonation until the bomb reaches an appreciable depth. It then acts as a mine and blows in the side of the ship.

When the target is a line of communication, such as

These are fragments of the 4000-pound bomb. They are about the right size to cause general destruction

a road or railroad, a large crater effect is desired on account of the resulting difficulty of restoring the roadbed, and to produce this a slight delay is required, enabling the bomb to bury itself before detonating.

The fuses must be so designed that the bomb can be carried by airplane with perfect safety, for in the event of a crash the safety devices in the fuses must prevent the bomb from functioning. Also, in case of a forced landing, when it is necessary for the safety of the airplane, to release its load of bombs, the mechanism of the fuse must allow them to be dropped "safe."

In designing the bomb body careful consideration must be given to adaptability to stowage of the bomb in the airplane, to its proper flight and to efficient blast effect. The structure of the present airplanes requires that large bombs be carried outside the fuselage, but since in that position they offer added resistance to the passage of the airplane through the air, a "stream-line" form should be used if possible. This "stream-line" form is also of advantage, since it tends to give high striking velocity and reduces the time of flight. All bombs must fly true, and to insure this they are guided in their flight by four fins, properly proportioned with respect to the body, and attached to it. The direction of blast from the detonation of a charge in a bomb is approximately perpendicular to the exterior surface of the explosive, and the bomb case should be so designed that the maximum blast will be in a horizontal direction, as this is most effective against the usual target.

Finally, the bomb as a whole must be designed so that it can be produced in quantity in this country, utilizing such facilities as will be available for its manufacture in the event of war. This last consideration is of the utmost importance.

With these general requirements the design of a 4000-pound bomb was undertaken. The results obtained with the 2000-pound bomb had been so satisfactory that this bomb was used as a guide.

The pictures show the bomb as developed. It is 13½ feet in length and 2 feet in diameter. The body is a cylinder of steel tubing, each end of which is closed by a steel casing, the nose being brought to a point, the rear end being a slightly convex plate ribbed to carry a rim, over which the cone of the fin assembly is fitted. The fin assembly is made up of four large sheet steel fins riveted to a sheet steel cone. The fins are braced in two places by steel tubes extending between the fins and riveted to them. The fin assembly is held to the body of the bomb by a steel tube which extends backward from the rear of the body, a nut on the tube engaging against the rear end of the cone and forcing the cone over the rim of the casting at the rear end of the bomb.

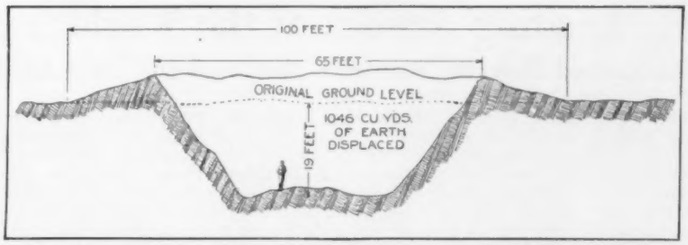
The bomb is equipped with two fuses, one in the nose, the other in the rear end of the bomb body. These fuses can be equipped with delay elements as desired, so that instantaneous action or delays of a few hundredths of a second up to several seconds can be obtained. The fuses have the usual wind-wheel safety feature, which operates as the bomb falls, the windwheels releasing the firing pins so that on impact the primers in the fuses will be struck and the bomb detonated.

For attachment to the airplane two lugs are provided which are bolted to the bomb body at equal distances from the center of gravity and spaced to fit the carrying device.

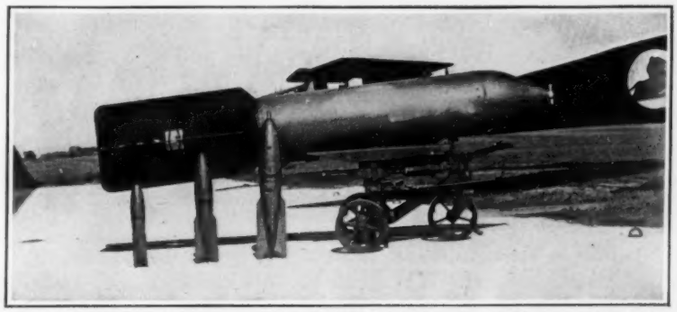
The bomb, though designated as the 4000-pound demolition bomb, actually weighs about 4300 pounds and has a main charge of about 2000 pounds of T.N.T. The design was drawn up by the Aircraft Armament Division in the office of the Chief of Ordnance, at Washington, the production of the metal parts was handled by Frankford Arsenal, Philadelphia, Pennsylvania, and the loading was done at Picatinny Arsenal, Dover, New Jersey.

The body was probably the largest container ever loaded with high explosive and one week was required for the filling of each bomb. The explosive T.N.T. is melted and poured into the case in increments, time being allowed for each increment to solidify before the next is added. It is interesting to note that after final pouring the charge was four days and more in cooling, while only about six hours are necessary for the charge of a 10-inch shell to cool.

The testing of the bomb took place, as has been mentioned, at Aberdeen Proving Ground. The largest airplane available at this time was a Handley Page, and the question naturally arose, first, as to whether it could lift so great a load, and second, as to what effect the release of so much weight, all at one time, would have upon it. A bomb loaded to weight with inert material was therefore used first to test the airplane and the carrying device. The airplane took off successfully and the bomb was dropped without apparent difficulty. The officer of the Air Service who piloted the airplane stated that when the bomb was released the airplane shot up about twenty feet, but the effect was no greater than that from a bad bump often encountered in flying.



This is an exact cross-section of the crater caused by the 4000-pound bomb at Aberdeen Proving Ground. The soil, falling back after the explosion, partly fills the crater and forms an embankment or rampart around its periphery



In practice the fin and fuses are not assembled to the bomb until the body is attached to the airplane. The shot truck is used in maneuvering the bomb under the airplane. A 25, 50 and 100-pound bomb are shown for comparison in size

The bomb completely assembled resting on a shot truck

With this problem disposed of, everything was ready for the final test. A loaded bomb was taken up and released from an altitude of 4000 feet. The observing party was stationed for safety in a tower fully 2000 yards from the point of impact, but even at this distance every feature of the test was clearly discernible.

The bomb fell perfectly, without apparent oscillation, and to those watching, appeared like a large pencil dropping from the sky. When it struck a great mass of earth and dense black smoke was blown up hundreds of feet in the air and several seconds later the crash of the detonation reached the observers. The bomb was equipped with a short delay fuse which allowed it to penetrate at least ten feet before it detonated. The formation of the crater smothered to a certain extent the blast or concussion from the detonation so that it was scarcely felt at the observation point. The pilot and observer of the airplane, however, though 4000 feet above, reported that they felt a decided bump.

The crater formed was immediately inspected and its appearance is clearly shown in the pictures and sketch. As the crater was approached it appeared like a small fort. The earth from the crater had been thrown out, forming a rampart five feet high around the edge; 1046 cubic yards of earth had been displaced, and a hole 19 feet below the original surface of the ground and 65 feet in diameter had been blasted out. This was probably the largest crater ever produced by a single projectile. Inside and around the crater jagged fragments of the bomb case were found, varying in weight from a few ounces to several pounds, which against a material target would have added greatly to the destructive effect of the blast.

Further tests of the 4000-pound bomb will be made to ascertain more completely its destructive effect, but considering the results already obtained and the targets against which it will be used in time of war, it is doubtful if a bomb of greater weight will be constructed for some time.

Witnesses of the destruction of the "Ostfriesland" and "Alabama" were deeply impressed by the work of the bombs, both in wrecking the superstructure and in sinking the ships by crushing in the hull below water. The targets, it is true, were anchored; but over against this is the fact that aerial bombing is a comparatively new art, capable of great development.

This shows how the earth is thrown up at the instant of the detonation of a large demolition bomb, which has occurred well below the surface

Looking down into the crater. Man is one-third of the way up. Water at bottom is from a source opened up by the shock of detonation

Leading Armies of the World

Comparison of the Active Armies, Trained Reserves, Available Manpower and Field Artillery of the Five Leading Powers

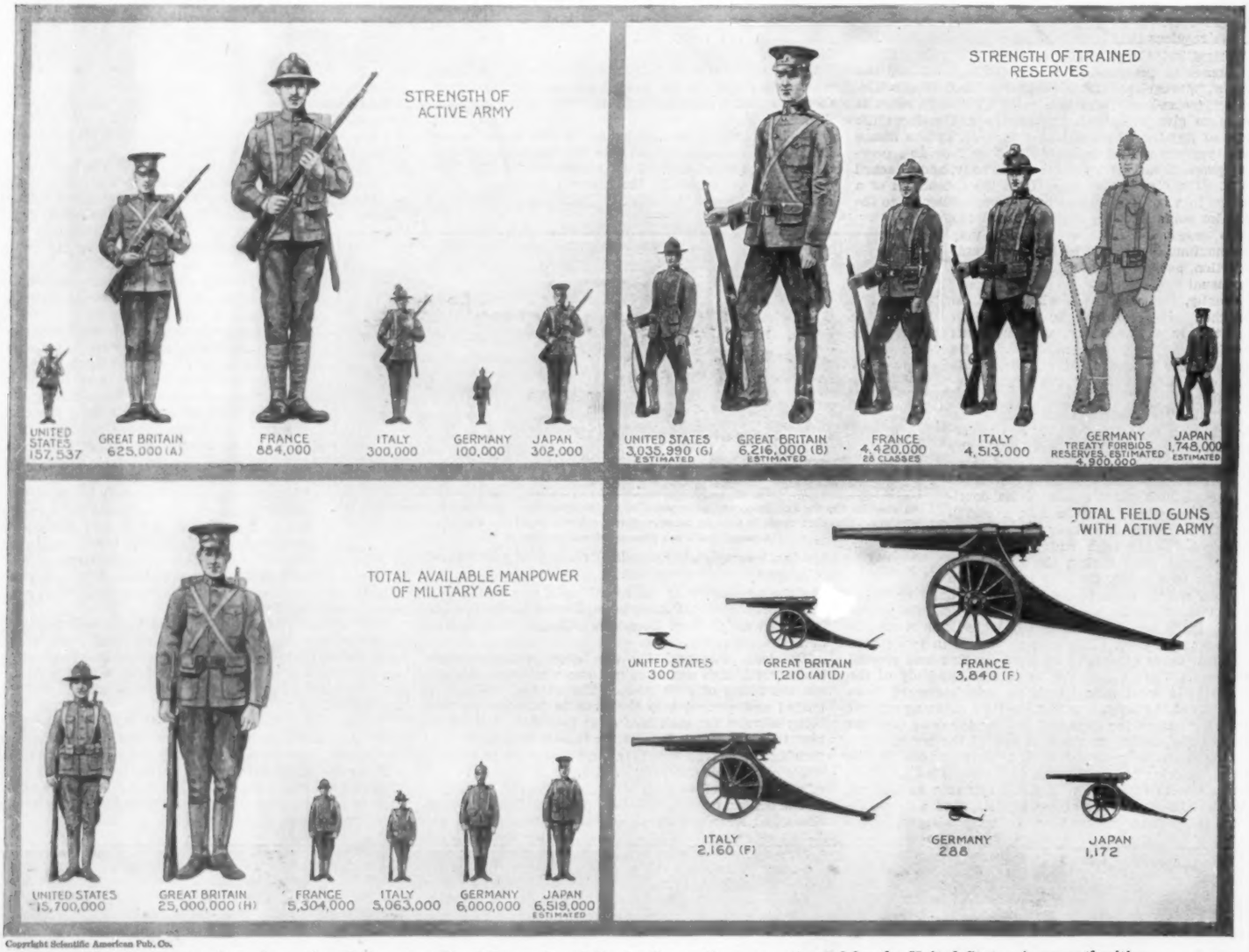
IT is a rather formidable task to attempt to make a reliable comparison of the strength of the various military powers—this for the reason that the late war, and the reduction of forces since the war, have made so great a difference in the strength and composition of armies, as compared with pre-war times, that only to the officers of our Military Intelligence are the facts known with any close degree of approximation. The table which is herewith published is made up from their statistics and represents the very latest figures that are obtainable as we go to press. The totals are given for the strength of the active army, the strength of the trained reserves, the total available man-power of military age, and the total number of field guns with the active army.

The United States

The strength of the active Army of the United States, as recently fixed by law, is 157,537 officers and men. This body is provided with a total of 300 field guns. By field guns must be understood mobile artillery, up to and including that of 6-inch caliber. The heavier artillery, whether caterpillar-mounted or on railroad mounts, or designed to be transported to the front and fired from fixed emplacements, is not included in these 300 guns. This reservation applies to the totals of the guns of all the armies included in this table. It will be seen that the strength of our trained reserves, as estimated by the War Department, is 3,035,990. This figure includes about 188,990 reserves, consisting of the National Guard and the Officers' Reserve Corps. At present there is no enlisted force in the Reserve Corps. In addition to these, there are 2,847,000 (estimated) non-enlisted veterans of the World War. The total available manpower of military age in the United States is estimated by Army Intelligence as 15,700,000.

Great Britain

It will be noticed that Great Britain is credited with an active army of 625,000; but it should be understood that this includes 274,000 white troops of the United Kingdom, of which 200,000 are serving at home and 74,000 are serving in India and are paid for by the Indian Government. The rest of the British total, or 351,000 of the active army, are colored troops, the bulk of which, of course, are in India. The total of 6,216,000 trained reserves of Great Britain includes an estimated total of 6,000,000 veterans of the World War and 216,000 men of the Regular Army Reserve, the Special Reserve and the Territorial Army. The total of field guns of the British Army, up to 6-inch caliber, is estimated at 864 guns with the British Army in the United Kingdom only. The number of guns outside of the United Kingdom is not known. To be added to this are 346 guns in the hands of British Artillery units serving in India with the Indian Army, the two items together giving the grand total shown in our table. The enormous total available manpower of military age of 25,000,000 given for Great Britain is to be explained by the large extent of the British colonies; but mostly it is due to the teeming millions of India. These figures are estimated by our Army Intelligence; and to arrive at a total, there was taken 5 per cent of the total population in India, 20 per cent in New Zealand, 12 per cent in the United Kingdom and 15 per cent in Canada, Australia and South Africa. All these percentages impress one as entirely reasonable.



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The above comparison shows the relative strength of the armies of the leading nations, as estimated by the United States Army authorities

France

The active French Army has a strength of 884,000; and the strength of the trained reserves included in 28 classes is 4,420,000. The total available man-power of military age is 5,304,000; and the total number of guns with the active army is 3840. It should be understood with regard to this artillery that, due to skeletonized organizations, all of the guns are not manned. The large proportion of the trained reserves of France and Italy to the total man-power of military age is very significant and speaks eloquently of the supreme effort made by those gallant countries in the recent war.

Italy

The strength of the active army of Italy is 300,000; and behind it is a trained reserve of 4,513,000, slightly larger than that of France. The total available man-

power is over five million, and the total number of field guns is 2160. As in the case of France, only a part of these guns are manned, due to skeletonized organizations.

Germany

Germany, as we all know, was required under the Treaty of Versailles to reduce her huge army to an active strength of 100,000; and this has now been done. Under the head of trained reserves, in our table, there is a blank which is to be explained by the fact that no organized reserves are allowed to Germany by the Peace Treaty. On the other hand, it is estimated by our Government that there are in Germany today 4,900,000 trained reserves, out of a total available man-power of six millions. The total field guns in Germany today are 288. This small figure shows how Germany has carried out the provisions of the Treaty, which called either for the surrender or destruction of its artillery. According to figures given out by the Disarmament Commission, Germany has destroyed 32,000 guns.

Japan

The strength of the Japanese active army is 302,000; and the estimated strength of her trained reserves is 1,748,000 out of an estimated available manpower of 6,519,000. In this matter of trained reserves, then, it is evident that Japan does not stand in nearly so favorable a position as France, Italy or Great Britain. The total number of field guns with the active army is 1172.

The Smaller Nations

Although they are not included in our table of the five leading nations, figures for Belgium, Holland and Portugal will be of interest. They are as follows: Belgium has an active army of 120,073, a trained reserve of 250,000, an available manpower of 1,125,000 and 772 field guns, all of which are not manned. Holland has 40,000 in her active army, including 20,000 organized militia. She has 360,000 trained reserves, a total available manpower of 1,000,000 and 171 field guns. Portugal's active army is 61,000, her trained reserves 622,000. Her available manpower is 922,000, and there are with the active army 292 field guns.

It will be noted that our table takes no account of guns in reserve—this for the reason that hitherto these figures have not been available. The various powers apparently are reluctant to make them known. The reserves of artillery are necessarily very large; and because the greater part of it is thoroughly up-to-date it is not likely that it will suffer any serious depreciation for many years to come.

THE LEADING ARMIES AT A GLANCE

	Strength of Active Army	Strength of Trained Reserves	Total Available Manpower of Military Age	Total Field Guns with Active Army
United States..	157,537	3,035,990 (g) estimated	15,700,000	300
Great Britain..	625,000 (a)	6,216,000 (b) estimated	25,000,000 (h)	1210 (c) (d)
France	884,000	4,420,000 (28 classes)	5,304,000	3840 (f)
Italy	300,000	4,513,000	5,063,000	2160 (f)
Germany	100,000	See note (e)	6,000,000	288
Japan	302,000	1,748,000 estimated	6,519,000 estimated	1172

(a) This includes the 200,000 white troops serving in the United Kingdom and 74,000 serving in India and paid for by the Indian Government. The remaining 351,000 are in India and on the Rhine, in Mesopotania, Silesia, Palestine, and elsewhere.
(b) Includes 6,000,000 (estimated) non-enlisted veterans of World War, and 216,000 Regular Army Reserve, Special Reserve and Territorial Army.
(c) 864 Guns with British Army (United Kingdom only—others not known).
(d) 346 Guns in hands of British Artillery units serving in India with Indian Army.
(e) No organized reserves allowed Germany by Peace Treaty, but there are estimated to be 4,900,000 men who were in her former army.
(f) All guns are not manned, due to skeletonized organizations.
(g) Includes 188,990 trained reserves (consisting of the National Guard and Officers' Reserve Corps. No present enlisted force in Reserve Corps), and 2,847,000 (estimated) non-enlisted veterans of World War.
(h) Estimated.
Of total population in India, 5% has been taken for this estimate.
Of total population in New Zealand, 20% has been taken for this estimate.
Of total population in United Kingdom, 12% has been taken for this estimate.
Of total population in Canada, 15% has been taken for this estimate.
Of total population in Australia, 15% has been taken for this estimate.
Of total population in South Africa, 15% has been taken for this estimate.

High-Speed Fighting Ships

By Hector C. Bywater

FROM the engineering point of view, the most striking feature of naval development in recent years has been the enormous increase in the power of propelling machinery. Figures which a few years ago would have been considered fantastic, if not impossible, are accepted today as commonplace. When completed in 1912 the British battle cruiser "Lion," designed for 70,000 shaft horsepower, was spoken of with bated breath, and more than one engineer of repute publicly expressed doubt as to whether any ship could be built to stand the tremendous strain of such a power plant working at top speed. Three years later the "hush-hush" battle-cruisers "Renown" and "Repulse" were laid down, the contract calling for 110,000 to 120,000 shaft horsepower. On her trial runs, made with the ship at normal draught, the "Renown" worked up to 126,000 shaft horsepower and covered the measured mile at a speed of 32.68 knots; her sister ship "Repulse," at deep load, reaching 119,025 shaft horsepower and a maximum of 31.7 knots. Although the scantlings of these two ships were exceptionally light, the hull exhibited no sign of structural weakness even when running "all out" in a seaway. Both ships, it may be mentioned, have Brown-Curtis direct-drive turbines.

The "Hood" marks a further big increase in engine power, for in order to drive this 41,200-ton mastodon through the water at a rate of 31 knots it was necessary to equip her with machinery of 144,000 shaft horsepower. This vessel is the first British capital ship to have geared turbines (Brown-Curtis type) and small-tube boilers. No official details of her steam trials have been published as yet, but it is known that she developed nearly 160,000 shaft horsepower and a speed of 31.9 knots on a displacement of 44,600 tons—that is, 3400 tons more than her normal displacement. In less than eight years, therefore, the "record" figure established by the "Lion" has been more than doubled. Nor is there anything to indicate that finality has been reached in this particular line of naval progress. The "Hood," in her turn, will be eclipsed by the six battle-cruisers now under construction for the United States Navy. Owing to modifications in their armor and underwater protection, the weight of these vessels has been increased from 35,300 tons to 43,500 tons. To achieve the designed speed of 33¼ knots, the machinery, consisting of turbines with electric transmission, will have to work up to 180,000 shaft horsepower—rather more than five times the figure for the battleship "Arizona," which as late as 1916 was the highest-powered vessel in the United States Navy.

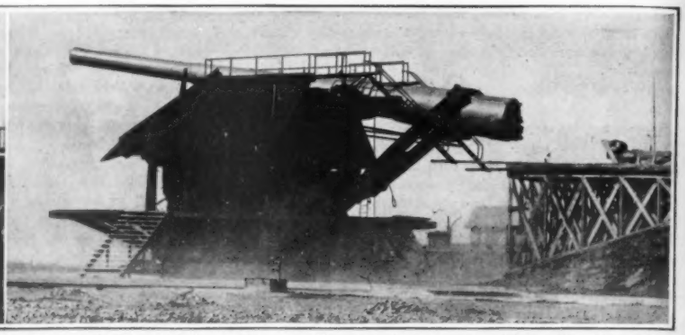
Equally remarkable is the advance which has been registered in the steam power of light cruisers. For the time being the record in this respect is held by the "Hawkins," a vessel of 9750 tons, completed last year and now serving as British flagship in China. She is fitted with geared turbines of 40,000 shaft horsepower, which give her a speed of 30 knots. There are four ships of this class, one of which, the "Effingham," is building at Portsmouth and not yet launched. Two further light cruisers of new type are now completing in England, namely, the "Enterprise" and "Emerald." Both were laid down only a few months before the war ended, but as a good deal of work had been done upon them they survived the wholesale cancelling of contracts which followed the signing of the Armistice. A third ship of the same class, the "Euphrates," was, however, scrapped. The "Enterprise" and "Emerald" represent a most interesting type of light cruiser. They were designed to act as scouts and screening cruisers for the British battle-cruiser fleet, a service demanding speed considerably superior to that of ordinary light cruisers. At the same time it was stipulated that they were to be of moderate displacement and to have an armament powerful enough to deal with the latest German light cruisers, which had a broadside of five 5.9-inch guns. The "Enterprise" displaces about 6500 tons at normal load. Her length over all is 565 feet, her extreme breadth 54½ feet and her moulded depth 30 feet 7 inches. It was ascertained by experiments with tank models that the desired speed could not be reached if anti-torpedo bulges were fitted and consequently this form of protection was dispensed with. But to minimize as far as possible the damage from torpedo or mine explosion, the boilers are divided into two widely separated groups, one group being placed forward and the other group well aft. The hull is also placed very extensively subdivided. Owing to the peculiar spacing of her three funnels, the "Enterprise" bears a strong resemblance to the battle-cruiser "Lion." She is engined with Brown-Curtis geared turbines developing the enormous figure of 80,000 shaft horsepower through four shafts, and a speed of 34 knots is confidently anticipated. Her main battery comprises seven 6-inch 50-caliber range-finding guns—of which five are on the center line and one on either beam. This gives a broadside of six guns and an end-on fire of four guns. In addition, there will be the usual anti-aircraft and machine guns, and twelve torpedo-tubes on triple-deck mountings. A deep belt of 3-inch high-tensile steel covers the sides in way of all machinery and boiler spaces, and is reinforced by a 1-inch upper deck. The absence of an anti-torpedo bulge, to which the British Navy has learned to attach great value, is considered a serious defect in these two ships. War experience did not bear out the assumption that high speed is itself a protection from submarine attack. Two British light cruisers, "Nottingham" and "Falmouth," were torpedoed whilst steaming at 24 to 25 knots, and zig-zagging, and there were other cases of ships being hit by torpedoes when traveling at full speed.

Just as the "Hood" will shortly be outclassed by the U.S.S. "Lexington" and her sisters, so in the near future will the "Enterprise" have to yield her place as the fastest light cruiser afloat to the new American vessels now building. These ships, 10 in number, will displace 7100 tons and have geared turbines of 90,000 shaft horsepower for a speed of 35 knots. It will be noticed from the tables given below that in general dimensions and armament they are somewhat similar to the "Enterprise," but their lines are not quite as fine.

According to authentic report, Japan has a very large programme of light cruisers in hand. The number of these vessels, as given in a list prepared by the U. S. Office of Naval Intelligence, is no less than 34. The "Tatsuta" and "Tenriu," begun in 1916, are in general design and appearance very much like big destroyers or flotilla leaders. They are 3500-ton ships, designed for 28 to 30 knots, and are armed with four 5.5-inch 82-pounder range-finding guns and six deck torpedo-tubes. In 1907 five cruisers of a heavier type were laid down as the "Kuma," "Tama," "Oh-I," "Kitakami" and "Kiso," names commemorating Japanese rivers. These vessels displace 5500 tons and have geared turbines of 65,000 shaft horsepower, from which a speed of 34 knots is expected. They are said to have an abnormally large oil-fuel capacity and a cruising radius of about 12,000 nautical miles. They carry a battery of seven 5.5-inch range firing guns, mounted in positions which enable five to train on the beam and four ahead and astern.

THE WORLD'S FASTEST LIGHT CRUISERS

	U.S.S. No. 4-13	H.M.S. Hawkins	H.M.S. Enterprise	Japanese Kuma
Year of completion..	1921-22	1919	1920	1920
Length over all, feet	555½	605	565	500
Beam, feet	55	65 (over bulge)	54½	49½
Draught, feet	13½	17½	16	15½
Displacement, tons..	7100	9750	6500	5500
Shaft horsepower...	90,000	40,000	80,000	65,000
Designed speed, knots	35	30	34	34
Fuel capacity, tons.	....	2600 (coal & oil)	1500 (oil)	2100 (oil)
Armament..	12 6-in. R.F. 7 4 T. Tubes	7.5-in. R.F. 7 6 T. Tubes	6-in. R.F. 7 12 T. Tubes	5.5-in. R.F. 7 4 T. Tubes
Protection...	Thin belt, no bulge	3-in. belt, bulge	3-in. belt, no bulge	3-in. belt, no bulge



Left: **Test of 16-inch 50-caliber Coast Defense Gun on barbette mount.** *Right:* **Test of 16-inch Coast Defense Gun on disappearing mount. This rifle, the most powerful in existence, is about 70 feet long, and weighs 152 tons. It fires a 2340-pound shell with a charge of 850 pounds of powder. The muzzle velocity is 2700 feet per second, the muzzle energy, 121,000 foot-tons, and the range, at 45 degrees of elevation, is 50,000 yards, or about 30 land miles. This gun can penetrate the armor on any foreign ship at any range**

The New Army Sixteen-Inch Gun

Exhibition Firing of the Most Powerful Coast Defense Gun in Existence

WHAT was probably the most elaborate program for the demonstration of new war material was that drawn up for the Third Annual Convention of the Army Ordnance Association, which took place recently at the new Proving Ground at Aberdeen, Maryland. The Army Ordnance Association is to be congratulated upon the extent and variety of the exhibits and the admirable precision with which the program was carried out in the presence of the several hundred assembled guests, including not only the members of the Ordnance Association, but also of the American Society of Mechanical Engineers and the Society of Automotive Engineers.

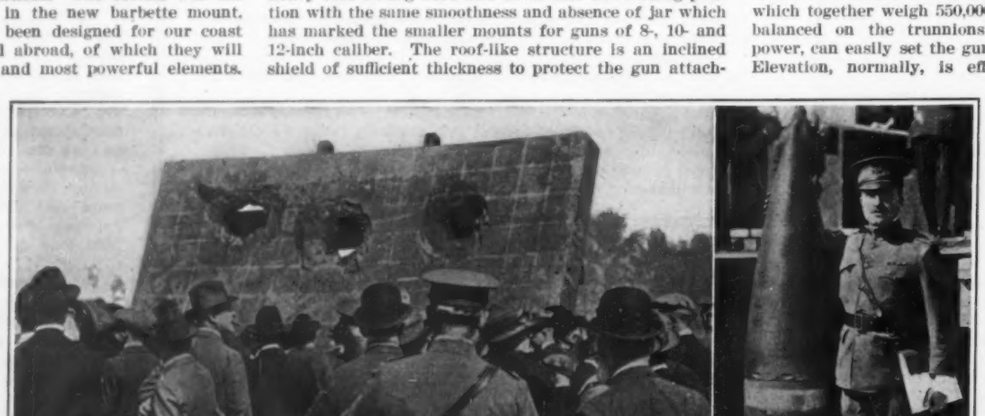
Limitations of space in the present article prevent the publication of any adequate details of this remarkable display of ordnance material and of the various demonstrations in the way of proof-firing, bomb dropping and maneuvering of caterpillar-mounted artillery. This will be understood when it is stated that there were over fifty separate exhibits of new material, part of it developed in our preparation for the late war and much of it representing absolutely new work which has been carried out by Army Ordnance since the Armistice.

Proof-Firing of Sixteen-Inch Army Gun

The first exhibit was the most spectacular and, indeed, the most important of all. It was the proof-firing of two 16-inch Army guns, weapons which from time to time have already been discussed in our columns. The first of these was the firing with full charge of a shell from the 16-inch coast-defense disappearing gun shown in our illustrations. The second was the firing of a similar piece in the new barbette mount. Both of these guns have been designed for our coast fortifications at home and abroad, of which they will form the most important and most powerful elements.

The Projectile

The 16-inch projectile, as will be seen from our illustration showing one of these alongside an officer whose height is six feet, is spectacularly big both as to height and bulk. Its exact weight is 2340 pounds. It is provided with a false nose made of light steel, which is screwed on at the forward end of the projectile, and is stream-lined so as to afford the easiest possible entrance for the shell as it passes through the atmosphere. Within the false nose is the blunter actual nose of the shell, which is provided with a cap of soft steel to assist the shell in shattering the extremely hard face of modern armor, so as to open the way for the body of the shell itself. Just how effective the projectile is as an armor piercer may be judged from our photograph of a 14-inch armor-plate which has been pierced, at extreme range, by three of these projectiles.



Heavy armor plate after penetration by three 16-inch projectiles. To the right is one of the 2340-pound shells

The Rifle

It can be readily understood that to impart a velocity of over half a mile a second to a shell weighing over a ton calls for a rifle of very exceptional dimensions and power. The 16-inch rifle which was built at the Watervliet Arsenal from designs drawn up by the officers of our Army Ordnance, is so well proportioned that the guests at the recent exhibition, although they were all technical men and familiar with large mechanical constructions, found it difficult to realize that this gun barrel was within a foot of being 70 feet in length, that its bore was 16 inches, and that it weighed 340,000 pounds or 170 American short tons. Another surprise came when the 850 pounds of powder which constitute a charge were fired. Both the burst of flame from the muzzle and such brown smoke as there is when "smokeless" powder is fired, were up to expectations, but the report was surprisingly "soft" for a charge of these great dimensions. However, this was not surprising to those of us who are familiar with proving ground effects. The writer remembers that when he was on board the "North Dakota" during battle practise, the sharp crack of a 5-inch gun was more severe on the ear drums than the deeper-noted report when the 12-inch gun was fired.

The barbette mount functioned satisfactorily, and the heavy rifle swung back and down into the loading position with the same smoothness and absence of jar which has marked the smaller mounts for guns of 8-, 10- and 12-inch caliber. The roof-like structure is an inclined shield of sufficient thickness to protect the gun attachment from small shell fragments and machine-gun fire.

The Sixteen-Inch Barbette Gun

Not far from the 16-inch disappearing gun was a sister rifle on a barbette mount. In the disappearing mount, the gun, upon discharge, is thrust back and down until she is below the parapet and sheltered from direct fire. In a barbette mount the rifle is permanently above the face of the parapet. The gun and its carriage rotate upon a massive turntable, consisting of a base ring bolted to the concrete foundation, and an upper ring known as the "racer," between which are 42 live rollers. A pinion attached to the racer engages a circular rack bolted to the outside of the base ring. By this means and by means of a micrometer index which is carried on the racer, the gun and its carriage can be laid in direction with an accuracy of $^1/_{200}$ of a degree. An electric motor and hydraulic speed gear permit the carriage to be traversed by power.

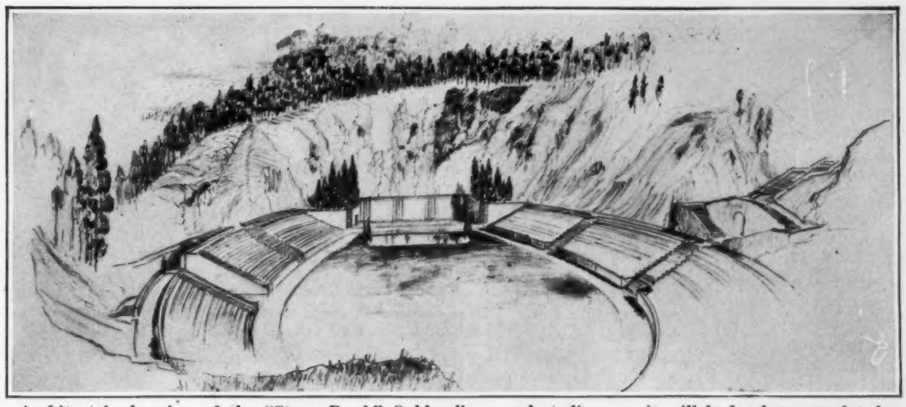
Bolted to the movable platform, one on each side, are two cast steel side frames in which rest the trunnions, the elevation of the gun being controlled by circular racks bolted to the right and left sides of the cradle. The range of elevation is from minus 7 to plus 60 degrees. The cradle forms a circular sleeve in which the gun recoils, and this cradle contains or supports all the mechanism which controls the recoil and counter-recoil of the gun. The cradle is a 50-ton casting, the inside of which is very accurately bored to fit the outside contour of the gun. The actual bearing on which the gun slides consists of a number of circular bronze strips bolted to the inside of the cradle. The gun and cradle, which together weigh 550,000 pounds, are so accurately balanced on the trunnions that one man, by hand power, can easily set the gun at any angle of elevation. Elevation, normally, is effected by electric motors.

The recoil is controlled by four oil cylinders, cast integrally with and around the cradle. The energy of the recoil is dissipated by throttling the oil with which the recoil cylinders are filled, by causing it to pass from the rear to the front of the piston through grooves cut in the wall of the cylinders. There is also a counter-recoil mechanism which serves to return the gun gently into battery —that is, into firing position. When the gun is laid at an elevation of 45 degrees, it has a range of 50,000 yards, or nearly thirty land miles. Even at this great range the shell will pass through the heaviest armor afloat in any foreign navy, as witness the 14-inch plate shown at bottom of this page.

Seats for 125,000

Oakland's Giant Stadium, Cut Out of the Center of a Mountain

CARVED out of the heart of a mountain of solid stone, a huge stadium is to be constructed at Oakland, Cal., according to H. H. Dunn in the *Boston Transcript*. The hill has been purchased, the inside hollowed out, and now all that remains to be done is the installation of the concrete tiers of seats, the gates and the Greek stage. When completed, this stadium will have a seating capacity of 125,000, and a total capacity, including the arena, or floor of the stadium, which covers three and one-half acres, of approximately 350,000 — a greater number than the population of the city which is constructing it. The hill itself covers five acres, and is somewhat more than 125 feet in height.



Architects's drawing of the "Stone Bowl," Oakland's record stadium, as it will look when completed

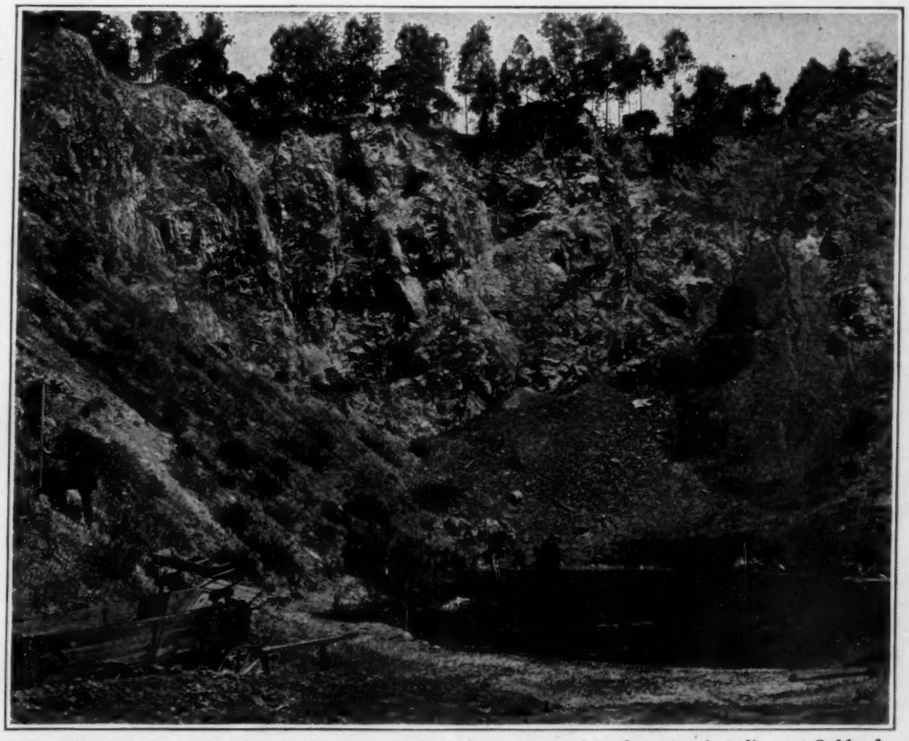
Owned some years ago by a company engaged in quarrying, this hill today is nothing but a shell of stone, a million and a half cubic yards of rock having been taken from its heart, leaving a perfectly flat, smooth floor of stone, walls in the shape of a complete circle surrounding this arena, and sloping slightly outward, as cut by quarrymen to prevent caving. Thus the walls are all ready for the construction of the tiers of seats and the concrete or stone stairways down into them. At one side of this artificially hollowed, yet natural, bowl or crater of stone, the quarrymen cut an entrance, narrow and straight, through which they carried away the rock blasted out of the mountain. This, which is the only opening into the inverted cone, will be converted, by means of concrete pillars, platform and gates, into a Greek entrance way.

Directly opposite the entrance to this huge quarry pit is a perpendicular cliff some 135 feet in height by about 200 in width at the base, against which the concrete stage, very simple and of early Greek type of architecture, will be constructed. The arena in front of the stage is large enough to play a full game of outdoor baseball, a football game, or hold a track meet of the largest size, while it will offer an unexcelled place for public meetings of all kinds, being large enough to accommodate all the residents of Oakland, men, women and children, at one time. A concrete wall will be placed around this arena, and from this wall seats will rise in tiers, as in the ancient Coliseum, with six concrete stairways between them, leading from the arena to the very top of the surrounding wall of natural rock. The plan is to erect these seats only half-way up the wall at first, thus providing seating accommodations for 125,000, but to add other tiers of seats as they may be needed. The solid stone walls give the bowl remarkable acoustic properties.

The old quarry, as it is hidden by a growth of gum and other trees, and as it has a very narrow approach or entrance, is ideal for the purposes of a stadium. It is protected by its high walls and trees from the glare of the sun, and the amount of work necessary to prepare the site of the seating, the stage and the arena is not difficult, nor will it necessitate any large expenditure of money.

The gully entering from the north side has been utilized as a stairway leading to the top of the cliff and carrying people to their seats easily and conveniently. The stairways sweeping each side of the entrance give a wonderful and beautiful approach to the seating portion of the stadium, and also have the advantage of distributing the audiences without confusion. The surrounding cliffs are subject to horticultural treatment, which will greatly enhance their beauty and their effectiveness as a background.

The "Stone Bowl," as the stadium site has come to be called, is only ten minutes by street cars from the heart of Oakland, and about five minutes from the residence district around Lake Merritt. It is directly at the end of one of the longest and most popular paved driveways of the eastern shore of San Francisco Bay. From the cliffs above the site of the stage one looks out over Oakland and San Francisco Bay clear into the Golden Gate. An effort is being made to complete the stadium in time to hold in it the next interscholastic games on this side of San Fransisco Bay. The cost will be comparatively light, since the quarrying company already has expended some $1,500,000 in the removal of the stone heart of the mountain, but left the hard rock floor level and the walls intact.



The cliff at the base of which the Greek stage is to be constructed in the natural stadium at Oakland. The spring and pool in the foreground are to be converted into a mirror lake at the foot of the stage

New Way to Recover Tin from Scrap Tin Plate

THE recovering of metallic tin from tin plate scrap such as tin cans, etc., is an important industry and quite extensively employed in the United States. A method has been patented in England for recovering such tin which is of considerable interest. Briefly it is as follows:

Tin scrap is treated with oleum to dissolve the tin, and the material is then lifted out of the acid and washed in water. Fresh acid is added to replace that used, and another batch is treated. After a time a basic sulfate $SnSO_4$. SnO_2, deposits, and is drawn off. The washing water contains some insoluble oxide, SnO_2, and some tin in solution. The dissolved tin is recovered by precipitation as sulfide or iron is added to neutralize the acid and obtain metallic tin. External heat is not required in the process, but the acid bath is maintained by the exothermic heat and the periodical additions of fresh acid at a fairly constant temperature of 45—55 degrees Centigrade and a strength of about 10 per cent free sulfur trioxide.

Stainless Iron—A New and Striking Product

STAINLESS steel is already a familiar product and much has been said about it. It is on the tables and in the kitchens of many American and British homes. But a new material has very recently appeared in England which is also the home of stainless steel. The new product has been named stainless iron and it is receiving much attention over there but is very little known in the United States.

The new stainless iron is really a milder grade of stainless steel which is a moderately high carbon, and therefore hard, steel containing about 12 to 14 per cent of chromium which bestows the stainless qualities. The main difference between stainless steel and stainless iron lies in the percentage of carbon, stainless iron having no more than 0.10 per cent carbon or about one-third that usually incorporated in stainless steel. The new iron is described as distinctly softer than stainless steel and amenable to manipulation operations quite impossible in the case of stainless steel. These working properties adapt it to use in hundreds of different directions, and it is believed that the requirements for stainless iron in the future are likely to be enormous, and to come from the most unexpected quarters.

It is anticipated by British authorities that the discovery of the alloy will profoundly modify industry so far as light metals are concerned. Because it is softer and more malleable, it can be forged, pressed and drop-stamped and hence utilized for a multitude of articles, parts and fittings which are now made of ordinary iron and various other metals, liable to be easily oxidized. It is stated that experiments in making the bonnets and wheel discs of automobiles of the new stainless iron have already proven successful, and pioneers and promoters of rustless iron are confident that its possibilities are almost unlimited.

Our Point of View

Soaring Men

THAT man would ever be able to soar, as the birds do, seemed as idle a suggestion, when it was first made, as the prediction of Professor Langley that man would some day fly through the air with a power-driven machine. The Wright brothers, after proving that power-driven flight was possible, made some experiments to prove that it was possible, also, to soar in a motorless plane. Such results as they achieved proved that successful soaring on any extended scale would require the construction of a very special machine. The Germans, forbidden by treaty to build power-driven airplanes, have turned to the development of soaring machines; and to judge from the results achieved in the Soaring and Gliding Competition recently held in the Rhön District, they have made a surprising and very creditable advance.

It seems that no less than 45 machines were entered in the competition. None of these carried any engine or means of mechanical propulsion, and all were constructed of extreme lightness, and along lines which the builders considered to be best suited for soaring. The achievements, both in the competition and in subsequent flights, were truly astonishing. One man was in the air 15 minutes and 40 seconds, during which time he covered a total distance of over four miles. Not the least remarkable feature of this flight was that his gliding ratio was 1 in 32—that is to say, for every foot of vertical descent in still air, he advanced at least 32 feet. Even more remarkable for duration was the flight of another glider who was in the air for 22 minutes before he lost control and crashed. The finest achievement, however, was that of a Klemperer-Aachen glider, a monoplane which remained in the air for 13 minutes and covered a distance of over six miles.

The details of this achievement, which took place after the competition had closed, are given by a writer in *Flight*, who records that several machines reached heights considerably above their starting points. In the 13-minute flight of the Klemperer-Aachen monoplane, it is stated that the pilot reached, at one time, a height at least 300 feet above his starting point. According to a map of his course, he described figures-of-eight and sharp turns, and indeed flew his machine with the apparent control of a power-driven airplane. During the first part of the flight, with the wind against him, he made little headway, but attained considerable height. Then, on turning across the wind, he gained speed over the ground, and the last half of the flight, which was generally with the wind, was covered in three minutes, or at a speed of about a mile a minute, which is pretty good for a machine without a motor.

Critics of the various performances, among whom was Handley-Page, speak of the designs of the gliders as being generally well-thought-out. The wing loading was very light, averaging about 1½ pounds per square foot. The take-off is of course an important feature; and the machines leave the ground quickly. We are told that in taking advantage of the gusts of wind, the pilot elevated as much as he thought the machine would stand, and when the gust was dying down he flattened out to the gliding angle.

Soaring for such lengths of time as these is possible only where upward currents of air are present. Skill in soaring consists in finding these currents and so manipulating the plane as to remain within them as long as possible. On the other hand, the pilot must extricate himself from a falling current, or even from stationary air, as quickly as possible; for in these he will rapidly lose altitude and come to earth.

The Gentle Art of Translation

ONE of the least appreciated of the arts, we have always felt, is that of good translation. It has always seemed to us that any thought capable of expression in one language was equally capable of expression in any other civilized tongue of adequate vocabulary. Words, to be sure, exist in French for which no single English word is able to do duty. But we do not believe that any connected expression of meaning can exist in French and defy transference into any of the major modern languages. The only praiseworthy translation is one that can successfully pose as original composition. Just as the table that shows marks of plane and saw is crude and unfinished, so is the literary composition unfinished that exhibits indications of the process whereby it was turned from German into English.

The rarity of translations that meet this standard is sufficient to give force to our initial remark. Nor is it difficult to put one's finger on the root of the trouble. It will be granted that the English-speaking person with halting command of French cannot translate into good idiomatic French. Parts of his production will be faultless to be sure; but other parts will show the evidences of English origin cropping out like a sore thumb. It might, on the other hand, seem that a dictionary knowledge of French, coupled with good command of English, would be a satisfactory combination for translation from French into English. That it is not so will appear on closer thought.

The person who is in any way deficient in the language of the original text has continually to look up words of the original. He has to search carefully through a column and a half of alternative renditions of words like the German "Zug," the English "case," in the doubtful hope that he will hit upon the correct one. Many times he has to hang up the first half of a sentence while he endeavors to settle the significance of the latter part, only to find that this cannot be done until he is sure what the first clause is all about. The man who has to read, say, his German original word by word and patch it together word by word again to form the translated English text, is working against a handicap which cannot possibly result otherwise than in a bastard production of English words in German grammatical forms and German mannerisms of expression, with just as much certainty as though the linguistic deficiency were on the other side. And if in the bargain the translator be a person of no slightest literary capacity, with absolutely no style of his own, no sense of what is strong and what is weak in his native tongue, there is missing the last check which might operate to hold him to a respectable performance.

Lest we be accused of exaggeration, we quote with faithful attention to every detail the following gem, culled from a manuscript received in ordinary course from a professional translator: "To bring the weighing to a vacuum and preserve in the reductions the precision of the forty thousandth it is necessary therefore to possess the elements of calculation of the thrust with a superior precision, which may be roughly fixed at a hundred thousandth." It will be noted that this, unlike the uproariously funny translation from German by a German which we copied from one of our Einstein essays some months ago, does not present anything which is definitely meaningless or wrong; its amusing character and the success with which it betrays its French origin lie merely in the use of expressions, technically correct and meaning what they are designed to mean, but which no English-speaking person would ever dream of using. After we had tinkered with it a bit, it read: "When we attempt to weigh objects in a vacuum, if we are to attain a margin of error as low as .0025 per cent, it is necessary that we be able to calculate the thrust even more closely—say, within a margin of .0081 per cent." Why could not the translator achieve this result?

The trouble with this passage—which exemplifies the sort of thing that happens everyday in commercial translation—is simply that the translator was not sufficiently acquainted with French to read the original, getting its meaning as he would have got that of an English sentence. A large proportion of the translation that is done today is done under this handicap, and results of the sort quoted are inevitable. It cannot be too strongly emphasized that translation is an art, if anything, more difficult than original writing. The man who writes the original has something to say, and he says it. The translator has nothing to say: he must listen to what another has said, and resay it in the secondary tongue. When he has no alternative but to repeat it substantially word for word, of course he runs afoul of a thousand and one divergences between the usage of the two tongues involved. Some of these things the incompetent translator will get right, because he has learned to take every advantage of a dictionary that reveals them when it can. But never will the man who is not a thorough master of both languages involved produce a translation that cannot be identified as such.

Looking Forward by Looking Backward

IT seems but a short while back that we were describing in these columns the interesting but hardly promising experiments of numerous inventors with the wireless telephone. Such descriptions were accompanied by photographs showing a veritable maze of instruments and wires and still more instruments, arranged in that unsystematic manner so typical of the laboratory installation. And to be quite truthful, from the early wireless telephone experiments of the Danish experimenter and inventor Poulsen, to the pre-war long-distance attempts both here and abroad, very little of a commercial value had been realized.

It is such a well-known story that reiteration would only prove detrimental—this story of the remarkable development of the wireless or radio telephone since the days of our participation in the World War. In the short space of two or three years the radio telephone became a practical, everyday means of communication, available for all manner of purposes, and exceeding by far the wildest dreams of the early workers in this art.

And what have we today? Radio telephone stations being installed as rapidly as possible in every leading center of the United States, for the purpose of sending out news bulletins, baseball scores, stock reports, crop surveys, weather bulletins, sermons, public speeches, and even music. These broadcasting stations, as they are called, are being installed and operated by large manufacturing companies, who are anxious to furnish such service in the positive knowledge that it will increase the demand for radio apparatus. The Government, too, is about to install radio telephone broadcasting stations, which are to replace in whole or at least in part those stations now rendering a similar service in the dot and dash language of the Morse telegraph code.

Nightly, this American ether of ours is filled with all manner of conversations, reports, bulletins, sermons, and music. Already in many an American family the evening's diversions depend a great deal on the activities of the broadcasting stations. With a loud-speaking telephone on the living-room table and with a simple receiving set the members of the family can receive all the news that is worthy of widespread attention, followed by a musical program.

But what of the future? Truly, there is no end to this radio telephone thing. The transmission of radio telephone conversation is still a somewhat expensive and elaborate task, especially if any real distance is to be spanned, although for short distances the equipment is quite simple and inexpensive. But in the broadcasting feature, we have only begun. Perhaps it may be that a time may come when special broadcasting stations will be operated for the sole benefit of certain subscribers, who will pay a monthly or yearly fee for the service. How the broadcasting stations will prevent non-subscribers from securing the full benefit of the service is a problem, to be sure; but we anticipate that a quite satisfactory and simple manner will be found to protect such service against unlicensed receiving sets. Perhaps the means may be an arrangement of con-

Our Point of View

stantly shifting wave lengths for the transmitter, with the same shifting wave lengths at the receiving end, the commutators or other devices performing this function being carefully synchronized. At any rate, if such a service should be found profitable and set up quite distinctly from the present gratuitous services, we may look to the day when the American family, by a slight adjustment of its radio receiving set, designed like a cabinet phonograph, may turn from heavy Wagnerian opera to light American musical comedy, and from a French song to a Slav march. Not plain phonograph music as at present, mind you, but real music from the leading theaters and concert halls of the nation. A worthwhile by-product for the theater and concert hall —and for the church, when we come to think it over.

A retrospective survey is just as astounding as this look ahead. So why may we not reasonably expect these various things to come to pass?

Last Voyage of the "America"

THE racing schooner "America," after seventy years of adventure such as seldom, if ever, has befallen a yacht, recently ended her wanderings and found a permanent and honored resting place at Annapolis. We might make diligent search of the records of yachting and not find another craft so famous, or one that has exerted so immediate and lasting an influence upon yacht architecture, as regards both model and sailplan.

It was in 1851 that Colonel Stevens and his confreres commissioned George Steers to design them a racing schooner, modeled upon the general lines of the famous pilot boats of that day. She was to be sent across the ocean for the purpose of racing against the best of the English cutters and schooners. The challenge possessed double interest from the fact that the proposed contests would be between representatives of the two leading maritime nations and between two entirely different types of yacht. The English cutter of those days, and the schooners too for that matter, were modeled after the so-called "codfish head and mackerel tail" plan, with rather blunt, full bows and a long, easy run aft. The "America," on the contrary, had a long, fine entrance and a greater ratio of beam to length. Moreover, the point of greatest beam was well forward of amidships in the cutters, but well aft of it on the "America." The most marked difference, however, lay in her rig, and particularly in her sails, which were so cut as to lie fairly flat to the wind, an effect which was greatly helped by the American practise of lacing the foot of the sail to the boom. The hempen sails of the British yachts, on the contrary, were relatively baggy, as compared with "America's" suit, and the foot of the sail was not laced to the boom, but allowed to hang in a rather full curve below and to leeward of that spar.

There can be no question that the fine weatherly qualities of the "America" exercised an influence upon yacht design throughout the world. The blunt bow disappeared, sails were re-cut and laced to the boom, and British yachts began to show the characteristic features of the American schooner.

In later years a somewhat similar influence was exerted in the period of sloop-versus-cutter races that set in about 1885 and continued for the next eighteen years. The development of yacht design in America and Great Britain, during the thirty-four years between the "America's" day and the famous races between the sloop "Puritan" and the cutter "Genesta," had been along widely different lines. We had developed a type of yacht with great beam, a shallow body, a deep centerboard, inside ballast, moderate displacement, and a large sailplan. Great Britain, thanks to a faulty rule, had developed a model with extremely narrow beam, a deep keel carrying a heavy load of lead, great displacement, and a small sailplan.

In the series of races that followed, the sloop invariably won against the cutter, until the first "Valkyrie," a Watson boat, with more beam and larger sailplan, showed qualities that made her a dangerous competitor against the centerboard sloop "Vigilant." Thereafter each type began to adopt the best features of the other, as will be seen from the fact that the "Defender" of 1895 had 19 to 20 feet of draft, as against 8 to 10 feet in the "Puritan" and other earlier sloops; was minus the historical centerboard; had over 80 tons of outside lead ballast; and carried a highly developed cutter rig. Her competitor, "Valkyrie," on the other hand, showed the shoal body and great beam of the sloop (her beam was about 26 feet as against the 15 feet of the early cutters) and had her mainsail laced to the boom. So closely have the later yachts approximated that in the races last year, it was difficult, at a distance, to tell the American from the English yacht. To find broad differences between them, it was necessary to see both boats together in drydock and climb aboard. Here the difference was very marked.

Sixteen-Inch Guns Then and Now

SOME fifteen years ago we were one of a party of guests who had been invited to Sandy Hook to witness the firing of the first 16-inch gun to be constructed in the United States. This was a built-up gun, designed by the Bureau of Ordnance of the Army, which was to serve as the type gun of a considerable number which were to form the principal weapon of our coast defenses. It was of the old, short-caliber, low-velocity type, which has since become obsolete for direct fire. Its length was only 35 calibers, and its muzzle velocity was about 2100 feet per second.

When the guests reached the grounds, they were received by Captain Crozier (better known to the present generation as General Crozier, Chief of Ordnance in the early part of the late war), and taken over to the Proving Grounds to inspect the new "monster gun." Captain Crozier stood upon the loading platform and briefly explained the characteristics of the gun. He concluded by telling us that this was the first time in the history of artillery that such a large charge as 600 pounds of powder had been fired. "I have full confidence in the powder," he said, "and am aware of no reason why it should not function as satisfactorily when it is fired in such a large mass, as it does in the much smaller charge used in our 12-inch guns; but in order to prevent the possibility of any injury to the guests or the personnel, I will ask you all to retire behind the distant bomb proofs." Which we all did.

Nothing untoward happened. The powder burned progressively; there was none of that pernicious "wave action of the gases," which was believed to have caused the bursting of one or two experimental guns a few years before, when smokeless powder was somewhat of a novelty to our ordnance experts.

That 16-inch gun, which was welcomed into the family of Brobdingnagian ordnance with so much acclaim, was destined to lead a solitary and neglected life for many years to come. Just about that time the fashion in ordnance began to run to long guns of 12-inch caliber, or thereabouts, in which armor-piercing energy was sought rather in the direction of velocity than of mass in the projectile. The Army built no more 16-inch guns, preferring to develop a 14-inch gun of long caliber and high velocity. The big fellow seemed to be regarded as somewhat of a white elephant, and it required the stimulus of the war to cause it, at last, to be shipped to Panama and installed as part of the defenses there.

Fifteen years after witnessing the firing of this first 16-inch gun, we received an invitation to attend at Aberdeen the firing of our second Army 16-inch gun, a 50-caliber piece, firing a 2340-pound shell with the high velocity of 2700 feet per second. As at Sandy Hook, the guests were given some of the particulars regarding the gun, among which was the announcement that the powder charge would weigh 850 pounds. It was just here that our mind was carried back to Sandy Hook, and the similar little talk given us by Captain Crozier; and by no means the least vivid item in this recollection was the fact that he warned us all to get behind the bomb proofs because of the enormous charge of 600 pounds of powder which was about to be fired. But in spite of the fact that some 500 or 600 guests, including many of the most famous engineers in America, to say nothing of quite a galaxy of high ranking military officers, were grouped closely around the gun, no suggestion whatever was made by the Proving Ground spokesman that we should even retire to a reasonable distance, much less to the bomb proofs.

Now the moral of all this, thought we, is not that Captain Crozier showed an unnecessary solicitude for the health of his guests, but that the advance in the manufacture of gun steel and of smokeless powder has been such, in the intervening years, that the bursting of a heavy piece of ordnance like this at its proof firing is about as likely a possibility as that a baby carriage will collapse when it is loaded with its first smiling infant. We have progressed far beyond the stage when hidden flaws can exist in the metal of a gun, or wave action during combustion may rip the gun apart.

Gas Turbine Perplexities

THE advantages to be derived from the development of a successful turbine are many and obvious; so much so that many of our ablest physicists and engineers have devoted earnest thought and effort to the problem of producing a prime mover of this type. Unfortunately, results have been in the direction of proving what cannot be done rather than what can; and it must be confessed that there are certain outstanding problems, both theoretical and mechanical, which, for the present at least, appear to be insuperable.

The literature upon this subject has become quite extensive, chiefly in the form of papers read before technical societies. We find one of the latest and most illuminating discussions of the subject in a recent issue of *The Engineer*, which frankly confesses that here is a problem that certainly embraces more genuine difficulties of a mechanical nature than were ever provided by the steam turbine or the internal combustion engine; while the thermo-dynamic considerations involved are in a class entirely by themselves.

The first outstanding difficulty is to overcome the losses in producing the required compression. Rotary compressors are ruled out because the pressures obtainable are too low, 100 pounds per square inch being the best that hitherto has been obtained; also it is a cumbersome method. Hence the reciprocating compressor is essential. But here we come up against the problem of dissipating the heat absorbed by the cylinder and cylinder head. The dilemma presents itself of keeping down the temperature of the metal, without reducing the temperature of the gas so far as to involve a big loss in thermal efficiency. A boiler furnace, it is true, stands 2500 deg. Fahrenheit; but the furnace metal transmits the heat, whereas the turbine metal must retain all it can hold short of being ruptured. This part of the problem is still unsolved.

The next outstanding question is that of effecting a compromise between the high velocity of the high-pressure, high-temperature gas, and the maximum allowable velocity of the turbine blading. Here it is found that, with stiff shafting, a peripheral speed of the blades of about 500 feet per second is the limit. But this is too slow for gas efficiency. Nor does compounding help very greatly. As matters stand today, the gas turbine, in thermal efficiency, falls far short of the best reciprocating gas engine; indeed we are told that the largest gas turbine unit, so far built, realized only 25 per cent of its designed output of 1000 kilowatts.

Hope for the future lies in the possibilities of water injection into the combustion chamber. By this expedient it would be possible both to reduce the temperature to the desired point and to utilize, on the blades of the turbine, the potential energy thus transferred from the gas to the water. Theoretically, the injection method is attractive.

Abraham Lincoln and the Repeating Rifle

How an Inventor's Struggle for Recognition Was Assisted by the Action of the President

UNDOUBTEDLY one of the secrets of President Lincoln's success in dealing with difficult problems was his fine sense of proportion. He saw the essentials and took hold upon them with a firm grip. So clear was his vision and so logical his mind that in studying a complicated problem he saw the controlling facts of that problem standing up as sharply and distinctly as the great peaks of the Alps stand out from the foothills below them. Consequently, he obtained results with a minimum of effort and moved to his goal with the directness of a well-shot arrow to the bullseye.

As always happens in such an emergency, Washington, during the War of the Rebellion, was flooded with inventions, and the various departments, the Congress, and even the White House itself, were invaded by a crowd of earnest men, who believed they had devices by the use of which victory for the Union forces could quickly be assured. Among those who went thus to Washington was a certain Christopher N. Spencer, a young machinist from New England. He carried with him a repeating rifle of his own design and bearing his name, which was destined to have a large share in the ultimate success of the Union armies, and was to become famous throughout the world.

The Inventor of the Repeating Rifle

The publishing of the present article about an invention which was fully described in our columns sixty years ago is due to the fact that Mr. Spencer is still alive—very much alive—and that he recently came in person to our editorial offices for a little talk about those early days. He brought with him as his visiting card a photostat of the front page of the SCIENTIFIC AMERICAN of January 25, 1862, containing drawings and description of his repeating rifle, the first of its kind to be successfully operated. Also, he left with us an extremely interesting photograph of a target made by Mr. Lincoln with one of the new rifles which he had given to the President.

Mr. Spencer carries his eighty-eight years very lightly and finds his recreation in active work. His memory is clear, even to details, and he sketched out the salient features of his life, when these were requested, with a facility which showed how gently the years had touched him.

Sharps' single-shot breech-loader was brought out in 1848, and in 1857 young Spencer, then twenty-four years of age, conceived the idea of building a repeating rifle with the magazine running down through the inside of the stock. He worked over the problem, making experimental guns until, in 1859, he felt justified in applying for a patent. It was granted to him on March 6, 1860. In those days he was working for Cheney Bros., silk manufacturers, of South Manchester, Conn., the place of his birth, and while with them he obtained a patent for an automatic silk-winding machine. This, by the way, has historic interest also, from the fact that it was the machine "with which Pratt and Whitney began manufacturing in their first rented room in Hartford." From his boyhood up firearms had exercised a strong fascination over Spencer and his spare time was given over entirely to the development of his gun.

Secretary Gideon Welles Helps Him

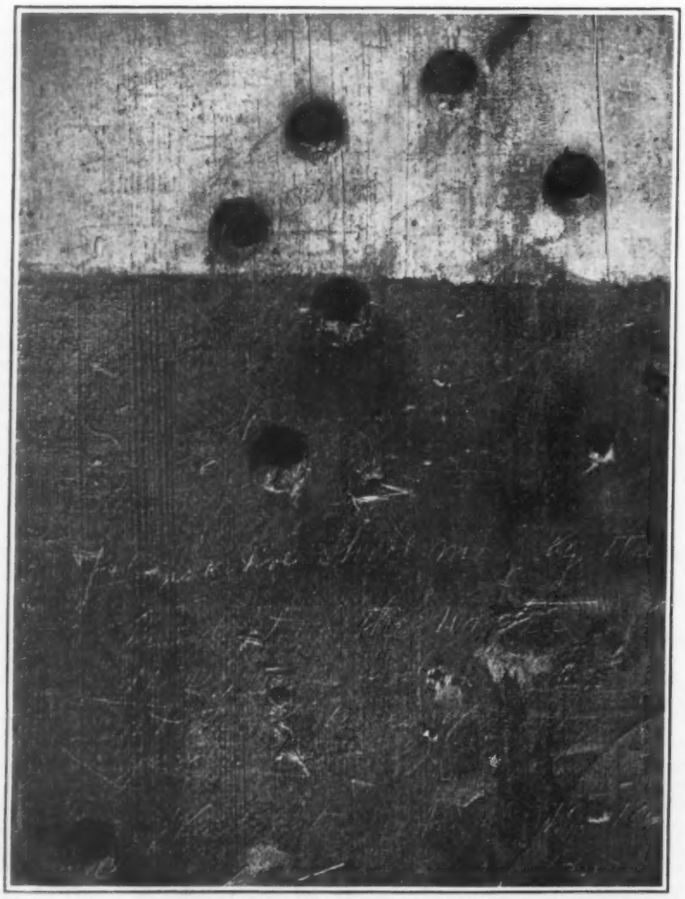
It seems that Charles Cheney, his employer, was a close friend of the Hon. Gideon Welles, Secretary of the Navy, and he and Spencer took a rifle to the Washington Navy Yard, where it was required to stand a test of firing 1000 rounds without cleaning. In the course of this trial Spencer was officially timed to have fired twenty-one shots in sixty-two seconds. This brought an order from the Navy Department for one thousand guns.

The navy contract had been filled many months before any order could be secured from the War Department. There was something strongly suggestive of times more modern when Mr. Spencer told us that a certain general of that day, "the fossil of the Ordnance Department, would not approve any 'new-fangled jimcracks.'" Recourse was had to the assistance of James G. Blaine, the Speaker of the House of Representatives, and through his influence and that of President Lincoln a contract was signed by the Assistant Secretary of War, Thomas Scott, for 10,000 of the new weapons. Before the close of the war the Government purchased 200,000, which did great execution at the Battle of Gettysburg and in other important battles of the war.

Mr. Spencer's account of his meeting the President, as related to us by himself is full of interest and is characteristic of the great directness and simplicity of Mr. Lincoln's character.

"Among my most pleasing recollections of the war times was a shooting match which I engaged in with President Lincoln. I had been delegated by our company to present the President with one of the rifles, which I did on August 17, 1863. On my arrival at the White House I was ushered immediately into the reception room, with my repeating rifle in my hand, and there I found the President alone. I took the rifle from its cloth case and handed it to him. He examined it carefully and handled it like one familiar with firearms. He requested me to take it apart and show the 'inwardness of the thing.' After carefully examining and approving the gun, he asked me if I had any engagement for the following day, and requested me to come over about 2 o'clock, when, he said, 'we will go out and see the thing shoot.'

On left, Mr. Spencer, now 88 years old, with his original repeating rifle of 1860. On right, Mr. Guy Hubbard is holding a Sharps single-shot breech-loader of 1848



Photograph of target made by President Lincoln in 1863, in a friendly contest with the inventor. The second shot, just below the white paint, is a bullseye; the others are bunched closely around it

President Lincoln Tries the Repeating Rifle

"The next day we started on time for the shooting place, which was about where stands the Washington Monument. With us was the President's son Robert and an official of the War Department.

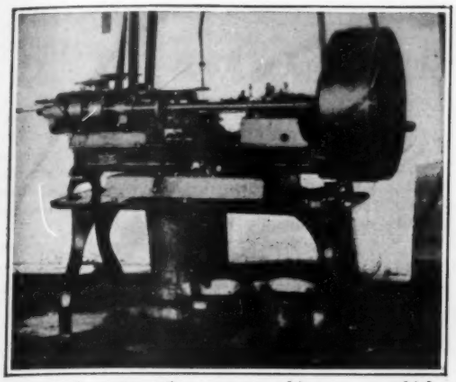
"On the way the President stopped in front of the War Department and sent Robert to ask Mr. Stanton, the Secretary of War, to come with us. While we were waiting Mr. Lincoln told us some good stories, and, noticing that one of the pockets of his black alpaca coat was torn, he took a pin from his waistcoat and proceeded to mend it, saying, laughingly, 'It seems to me that this does not look quite right for the chief magistrate of this mighty Republic.' Robert reported that Mr. Stanton was too busy to accompany us. 'Well,' said the President, 'they do pretty much as they have a mind to over there.' The target was a board about 6 inches wide and 3 feet long, with a black spot painted at each end. The rifle contained six 50-caliber, rim-fire, copper cartridges. Mr. Lincoln's first shot was to the left and 5 inches low, but the next shot hit the bullseye and the other five were placed close around it.

"'Now,' said Mr. Lincoln, 'we will see the inventor try it.' The board was reversed and I did somewhat better than the President. 'Well,' he said, 'you are younger than I am and have a better eye and steadier nerve.'"

The reproduction of this interesting relic is from a photograph of the target which Mr. Spencer left with the editors. The original is among the war relics at Springfield, Illinois.

Invents the Automatic Turret Lathe

After the war Mr. Spencer went to Amherst and was there associated with C. E. Billings, of the Roper Repeating Arms Co., and in 1868 Mr. Billings and he started the Billings and Spencer Co., Mr. Spencer co-operating in the development of the drop-hammer. He is still a director in that company. Somewhat later Mr. Spencer invented a machine for turning sewing-machine spools, and this suggested to him that it might be possible to make metal screws automatically. Out of this effort came that great invention, the automatic turret lathe. Joseph Wickham Roe, of Sheffield Scientific School, Yale University, speaking of the device, says: "The



Spencer's automatic screw machine, upon which the screw machine industry is founded

importance of the invention can hardly be over-estimated. It ranks with Maudslay's slide-rest and the turret tool-holder."

A Steam Automobile of 1862

This brief review must necessarily omit mention of many of the inventions and mechanical appliances of Mr. Spencer, but a brief description of his steam automobile of 1862 will be of historical interest. To an ordinary four-wheeled buggy he added a steam boiler and an engine. The boiler was secured at the rear and the engine at the center of the body.

The boiler was tubular, vertical and, of course, coal fired. The tubes were made out of rejected Spencer rifle barrels, turned down to the required thickness of shell. The engine was two-cylinder, with the cranks set at 90 degrees, the bore being 2½ inches, the stroke 5 inches. Forced draft was obtained by leading the exhaust pipe into the smokestack.

There was a chain drive to the rear axle, which rotated. Each wheel was provided with a ratchet, and each end of the axle carried a circular flange, and within each flange, engaging the ratchet, were pawls. This arrangement allowed the outer wheel to move faster than the inner wheel in turning a corner. So there was one drive forward and no reverse. The steering shaft carried a pinion, which was geared into the "fifth wheel" of the wagon.

This steam car Mr. Spencer built to carry him to and from his work. On the race track he was able to keep up with the fastest trotting horses. On the road his speed was limited by the rough condition of the surface. The tubular boiler, with its many tubes of small diameter, and the use of the (then) abnormally high steam pressure of 150 pounds to the square inch, was a long step in advance of the current practice of that day.

So typical has been Mr. Spencer's life of the ceaseless activity of a born American inventor that we append the following chronological record, following his birth in 1833:

1846. Began study of mechanics under grandfather, an artilleryman and armorer in the American Revolutionary Army. First work was making a hack saw by nicking an old carving knife on edge of an axe, and with this sawing off grandfather's Revolutionary musket to make a carbine.

1848. Built successful working model of steam engine, 1-inch bore and 2-inch stroke, from information contained in old volume of Comstock's Philosophy.

1848-53. Served time as machinist with Samuel Loomis and with the Cheney Brothers, of South Manchester, Connecticut.

1853-54. Served time as locomotive machinist in shops of the Niagara Falls division of the New York Central Railroad at Rochester, New York.

1854-57. Served time as gunsmith under Col. Samuel Colt at Hartford, Connecticut. Helped to install machinery in present Colt Armory.

1857-62. Machinist and inventor for Cheney Brothers, South Manchester, Connecticut. Studied drafting under Mr. Hezekiah Conant, the Hartford inventor.

1858. Invented the automatic thread-spooling machine. This revolutionized the thread industry and brought the Coats Company to America.

1860. Patented the Spencer repeating rifle, after three years of experimentation. This was the first dependable breech-loading and repeating rifle using metallic cartridges and was the first one to be adopted in the United States Army. About 200,000 were issued to the Union Army during the Civil War, and they were used with great effect.

1862. Built and operated the first successful automobile in Connecticut.

1862-65. Superintendent of the Spencer Rifle Company of Boston, Mass., and at the front instructing the troops in the use of the Spencer gun. Demonstrated it to and dined with General Grant and Flag Officer Foote on latter's flagship two days before Union fleet ran the batteries at Vicksburg. In August, 1863, taught Abraham Lincoln how to fire the gun.

1866. Invented the so-called Spencer-Roper repeating shotgun, first practical repeating shotgun, and founded company to build it at Amherst, Mass.

1868. With Mr. Charles E. Billings founded the Billings & Spencer Company of Hartford, Connecticut.

1868-76. Developed the board drop and various drop forging processes.

1873. Invented the automatic screw machine.

1876. With Mr. George A. Fairfield founded the Hartford Machine Screw Company, at Hartford, Connecticut.

1880. Invented the so-called "pump" or "trombone" action repeating rifle and repeating shotgun. Founded the Spencer Gun Company at Windsor, Connecticut, to build them.

Steam wagon built by Spencer in 1862, which he used to go to and from work

1883. Traveled through Europe with partner, Mr. Albert Bierstadt, the artist, and demonstrated the pump gun before the high commands of England, France, Italy, Austria and Germany.

1885-1912. Development work upon automatic screw machine and steam automobiles. Invented the Spencer double-end automatic and the universal five-spindle automatic.

1912. In eightieth year invented the New Britain six-spindle automatic screw machine.

1912. Mechanical engineer at the New Britain Machine Company. In 1920, when eighty-seven years old, took up study of aviation and since then has made nearly twenty aeroplane flights.

Scientific American.

A WEEKLY JOURNAL OF PRACTICAL INFORMATION IN ART, SCIENCE, MECHANICS, CHEMISTRY AND MANUFACTURES

VOL. VI.—NO. 4. NEW YORK, JANUARY 25, 1862. NEW SERIES.

Improvement in Breech-Loading Rifles.

The accompanying engravings illustrate the construction of Spencer's famous breech loading rifle, about which so much has been said, and for which large orders have been issued by government for the use of both the army and navy. It is designed for elongated shot, and has in the breech a magazine of prepared cartridges, which are fed forward into the barrel by a forward and back motion of the trigger guard, operating as a lever; the same motion withdrawing the empty cartridge cases.

The most important features in the invention are the plan for securely locking the breech block, and the arrangements for withdrawing the cartridge cases. Figs. 1 and 2 are sections through the breech and lock in Fig. 1. At this point the slot is so formed as to permit the block, F, to rise, and it is pressed upward by the spiral spring, g, closing the breech behind the cartridge, and resting firmly against the square wall, a', of the slot, as represented. In this position the rifle is to be discharged. After firing, the lever, G, is again carried forward into the position shown in Fig. 2. The first part of this motion draws the block, F, down into its notch; the lever, G, turning upon the fulcrum, h, and acting upon the block through the medium of the rod, j. As soon as the block, F, is drawn home into the notch the fulcrum of the lever, G, is changed to the pivot, b, around which the piece, E, with the block, F, then turns. This motion also withdraws the empty cartridge case from the barrel.

The Devotion of Agassiz to Science.

Shortly after his arrival in this country, Agassiz delivered several lectures on Ichthyology, in the old Crosby-street Medical College. Prof. Redfield got up a dinner in honor of "the immortal Swiss," as some called the learned stranger. To this dinner were invited the different scientists of the city. In the meantime, a fisherman had caught a rare fish, and conveyed it to Agassiz. It was enough. Immured in a private room assigned him in the college, he set to work on the study of his new acquisition. An attempt to inject the specimen proved both difficult and tedious. At length the dinner hour, three o'clock, had nearly arrived, when a scientific gentleman, assisting him, ventured to suggest that it was high

SPENCER'S BREECH-LOADING RIFLES.

of the gun, Fig. 1 showing the parts in the position which they occupy when the gun is loaded, and Fig 2 when receiving the charge. Fig. 3 is a plan view

To this end a small lever, c, is pivoted at its lower end to the piece, E, in such position that it may catch forward of the lip on the base of the cartridge. At the

time to go to the dinner. To which the absorbed philosopher replied, in utter astonishment, "Leave this to go to dinner! My dear sir, these opportunities are precious. This specimen can

Details of the first successful repeating rifle, as shown in the Scientific American of Jan. 25, 1862

Metallographic Testing

A SECOND edition of Circular 42 of the Bureau of Standards has been issued on this subject and may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C.

The value of the results of the metallographic examination as related to the testing of metals is now generally recognized. While the mere determination of certain mechanical properties may be sufficient in routine testing, for a complete working knowledge of metals and alloys a much more extensive study, particularly of the conditions which determine the properties, is necessary. The study of these fundamental conditions, structure, constitution, mechanical and thermal treatment, etc., constitutes the subject of metallography, using the term in its broad sense and not limiting it to microscopic examination as was formerly the custom.

The circular describes briefly the conditions which affect the properties of metallic materials under the following headings: Microscopy and structure; thermal analysis and heat treatment; mechanical working of metals; chemical and metallurgical factors, and conditions of melting.

The circular summarizes the conditions under which metallographic tests will be conducted by the Bureau, and specific directions concerning shipping, assembling, etc., are given.

The circular is now ready for distribution, and until it is exhausted copies may be obtained from the Superintendent of Documents in Washington.

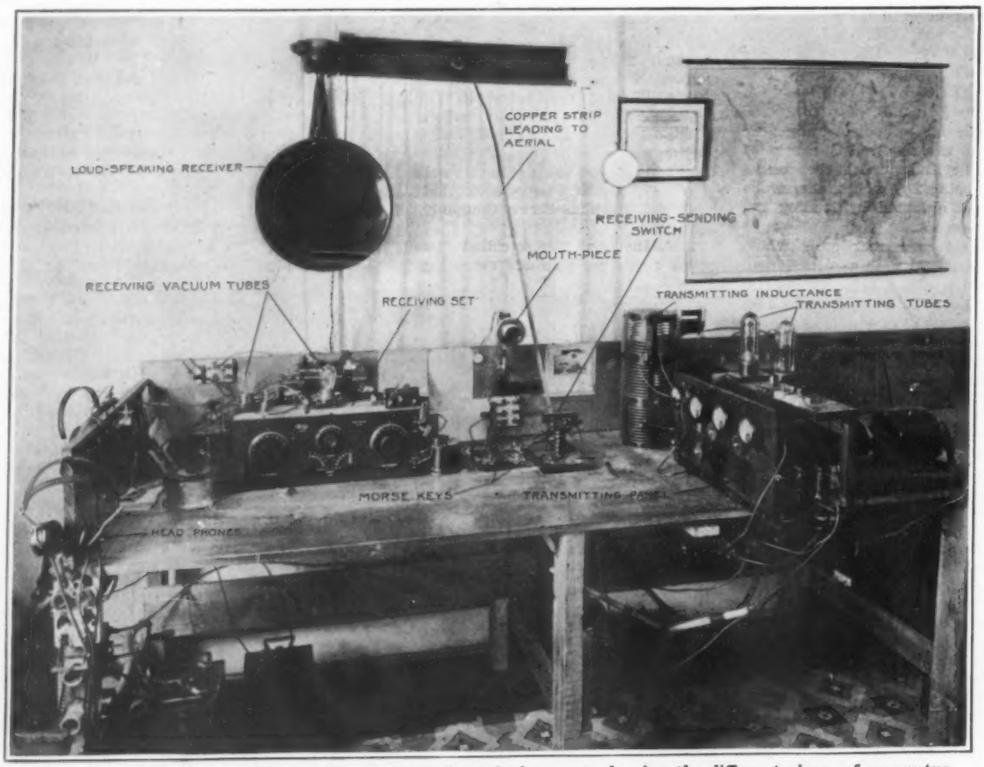
News and Music from the Air

What the Radio Telephone Means to the Farmer and Business Man at Home and at Work

By Pierre Boucheron

WHAT is the most unique yet withal fascinating hobby of modern times? A safe guess, surely, is the radio telephone. To conceive of thousands of boys, young men and grown-ups throughout the United States using the same medium to talk with one another in much the same manner as a roomful of people at a reunion or large sized assembly; to listen at given intervals to concerts where all manner of instrumental and vocal performances are faithfully reproduced; to intercept the news of the nation as broadcasted by various central stations in the larger cities; to receive timely and valuable agricultural reports of importance to farmers—all this constitutes an achievement that may well be called the hobby of hobbies. The achievement is still more important when it is considered that these radio telephone activities are a product of the resourcefulness and inventive genius of the American youth. Helped along by our judicious yet liberal laws for the control of amateur wireless activities, this pastime has grown in a few years from one of a few hundred followers to one of several hundred thousands. To be exact, there are approximately 300,000 amateur wireless men in the United States today.

One phase of the wireless hobby that is by far the most responsible for this rapid growth is the rapid and successful development of radio telephony. It is true that amateur wireless telegraphy has been an American institution for the past ten years or more, but the art in the past has been largely confined to professional telegraphers or to those who had the time and patience to master the art of sending and receiving the Morse or Continental Codes. Many boys and young men were attracted by the initial fascination of communicating without wires, but unless they were willing to devote a certain amount of time, say a year or more, to systematic telegraph practice, the art soon lost its charm since there was not much amusement in listening to rapid and meaningless dots and dashes. The war, which has been blamed for so many ills, did one good turn for amateur radio by training many men in its use and by developing the radio telephone to a remarkable point of operating efficiency. These trained men went back to civilian life and to amateur radio. Incidentally, they spread the gospel to others, with the result that we have today a formidable army of enthusiasts, more characteristically known among themselves as "bugs."



Typical amateur transmitting and receiving radio telephone set, showing the different pieces of apparatus arranged on a simple wooden bench

The radio telephone soon appeals to the average citizen after a brief acquaintance with its possibilities; indeed, that is why, where formerly none but schoolboys played with radio telegraphy, today all manner of professional men and even women have joined the ranks of radio telephone operators as an indoor pastime. This is not strange when one considers the fact that with an inexpensive receiving set erected in a few hours' time, one is soon "listening-in" on the doings of the world, so to speak. Not listening in as an eavesdropper, mind you, for wireless conversations are of the informal, good-fellowship kind—harmless, instructive, and as interesting as an open forum.

To get back to more general radio matters, there are in the United States three broad classes of radio telephone activities, as follows:

1. Commercial radio telephony.
2. "Wired-Wireless or radio applied to wire systems.
3. Amateur radio telephony.

The first class or phase, commercial radio telephony, holds considerable promise for the immediate future, although at present its scope and exact usefulness are not quite as clearly delineated as the amateur application. Moreover, when placed on a commercial basis, the initial expense and maintenance are necessarily higher than for amateur requirements. Adjustment of the apparatus and test periods must be reduced to a minimum, for time plays an important factor as compared with the amateur who has plenty of time at his disposal. The present land line telephone does everything that the commercial radiophone is capable of doing, with the possible exception of radio telephone service to ships at sea. Then, too, there are other special cases where it could be used to excellent advantage. Simplicity of operation and absolute reliability at minimum cost are therefore the factors with which future development must concern itself to make commercial radio telephony popular. To this end, the engineers of the largest radio corporation in this country are now engaged in perfecting several standard radio telephone sets, each designed for a specific purpose, ranging from small- to high-power outputs.

"Wired Wireless," a somewhat paradoxical expression, applies to a recent development where radio principles are used in long-distance wire telephony and telegraphy. Quite effective multiplexing is made possible by the use of radio waves which are *guided* by wires already in use for other purposes. In fact, from six to ten simultaneous channels of communication are sometimes available on a single land line wire. The "wired wireless" telephone may be used in conjunction with present power transmission lines, steam and electric railway tracks, metal fences, and so on, thus proving valuable and economical to central power houses, sub-stations, and to telegraph and telephone trunk line systems. Incidentally, we may reasonably look forward to future transoceanic cable telephony through the application of the "wired wireless" principle.

But amateur radio telephony is easily the most popular application of the radio telephone up to the present time, because, as previously outlined, it finds ready application for a variety of purposes which at once become interesting and fascinating for social intercourse, as a scientific hobby, or for the broadcasting of information and music.

As an illustration of the importance which the United States Government attaches to the amateur radio telephone, the Agricultural Department is considering its use to replace the present radio telegraph broadcast system which covers about half the country. This existing system, by the way, was started April 15 of this year from air mail radio stations at Washington, Cincinnati, St. Louis, Omaha, North Platte, Neb.; Rock Springs, Wyo., and Elko and Reno, Nev., each one of these stations having a radius of 300 miles.

At eight o'clock each morning, market reports covering grain and livestock, fruits and vegetables, are transmitted by regular wire to the above-named air stations. From these points, together with local market reports, they are sent broadcast by radio telegraph. Anyone equipped with simple receiving instruments may pick up these reports with little difficulty; and, consequently, their value to farms, in banks and in commercial clubs has been fully appreciated, more and more receiving sets being installed throughout the country.

The difficulty with the Government's broadcasting is that it is done by radio telegraph, so that the signals can only be read by persons proficient in copying Morse code. While the messages are copied by eager enough local amateurs, there are not enough of them to permit broad application of the service. The radio telephone, on the other hand, will enable any farmer equipped with a moderate-priced receiver to take advantage of the service.

To this end, when the Government Departments are reorganized all communication matters such as these radio agricultural reports, which now are handled jointly by the Agricultural and Post Office Departments, will probably be brought under the jurisdiction of the Post Office Department. In fact, a post office official recently sailed for Europe to seek ideas bearing on the establishing of an extensive radio telephone stock market and weather report service to be operated by the Government. This contemplated service will shortly be available to every farmer in the country who cares to make the small investment required to purchase the necessary receiving apparatus.

While this Governmental interest in the value of the radio telephone is steadily thriving, private organizations are planning unique broadcasting services of their own. Two large companies have already established powerful radio telephone stations at certain centers, from which they send out news at stated intervals in addition to frequent concerts. Perhaps the greatest and most striking demonstration of this news-reporting method was the one staged at the recent Dempsey-Carpentier boxing match, when more than 300,000 "ear witnesses" listened to the reports of the fight round by round. The station was located at Hoboken, N. J., and the power of the radio telephone set employed was sufficient to reach amateurs within a circle of several hundred miles. The large radio

company which reported the big fight now proposes to report future national events in much the same manner.

While it is true that the American amateur was probably the first to put the radio telephone to practical use, foreign countries are also planning popular broadcasting features. An instance is to be found in Germany, where the government has taken a hand by broadcasting stock exchange news, weather reports, etc. In fact, the German Government is now building 1500 standardized receiving sets which the Government itself will place in various banks and business houses throughout Germany for the reception of this broadcast service. The German Government also proposes to send out from one of its powerful stations the music from the State Opera House in Berlin.

In addition to the boys, young men and engineers who have been drawn to the ranks of the amateur radio telephone, there are the business and professional men, many of whom are prominent and well to do. They have read in the press and magazines of the fascination and achievement of wireless, and their interest has been aroused to the point of actually installing receiving equipment in their homes as well as on their private yachts, with the view to operating the sets themselves.

The vacuum tube, often referred to as the modern Aladdin's lamp of radio, is largely responsible for the present-day efficiency of the radio telephone as contrasted with the pioneer experiments of early investigators back in 1906, who employed the singing arc lamp as a generator of the required high-frequency undamped oscillations. Today all that is required to produce wireless speech is a simple enough electrical circuit employing one or more vacuum tubes and several necessary accessories. A 100-foot antenna and a suitable grounding connection are easily installed, and these simple devices are sufficient for transmission and reception purposes. The matter of distance is entirely dependent upon the number of tubes and the power used, as well as the proper adjustment of the apparatus. It is not within the province of this article to give complete specifications. Inquiring of any radio supply house or manufacturer as to parts and prices is, after all, a most effective way to secure definite information.

Briefly, to erect a small receiving set capable of intercepting wireless telephone conversations, concerts, Government reports, etc., the cost need not exceed $25.00 as an initial expense. The cost of erecting a combination sending and receiving station, however, will be considerably more, since transmission entails the use of greater power. Several hundred dollars should be sufficient for a sending and receiving station. If one is going in for wireless telephone transmission as well as reception it will be necessary to secure a station license as well as an operating license from the Radio Inspection Bureau of the Department of Commerce, whose representatives are located at all important cities.

Judging from present-day development, there is little doubt that a few brief years hence will see a wide and popular use of the radio telephone. A practical application will be the radio victrola, so to speak—a service available to anyone possessing the necessary receiving apparatus. The broadcasting service is now and will continue, no doubt, to be gratis, the service being maintained by manufacturers of apparatus as a publicity and service feature. The average home will be equipped with a portable receiving unit suitable for any room. A small loop of wire will serve as the receiving antenna, picking up the news of the day. Concerts will be heard, and possibly sermons will be preached on Sundays. Of course, all this transmission will take place at certain central stations. Your average citizen will simply turn on a switch at scheduled hours and the radio telephone will operate in somewhat the same fashion as the usual cabinet talking machine. Indeed, there is nothing of the prophetic dream about this statement, for the thing has almost come to pass.

Commercial radio telephone transmitter, employed in broadcasting work. Note that the operator speaks into a standard desk-type telephone instrument

The Mechanics of Ordnance Figures

ACCURACY to the fineness of a few millionths of a second and the capacity for producing a flash of light within a duration not exceeding 0.00001 second are among the features claimed for a new timing device developed by the United States Bureau of Standards. Veiled as a secrecy in relation to the gun-firing investigations of the Bureau of Ordnance, Navy Department, during the war, only its recent disclosure accords the instrument recognition in measuring any small time interval which may be recorded electrically.

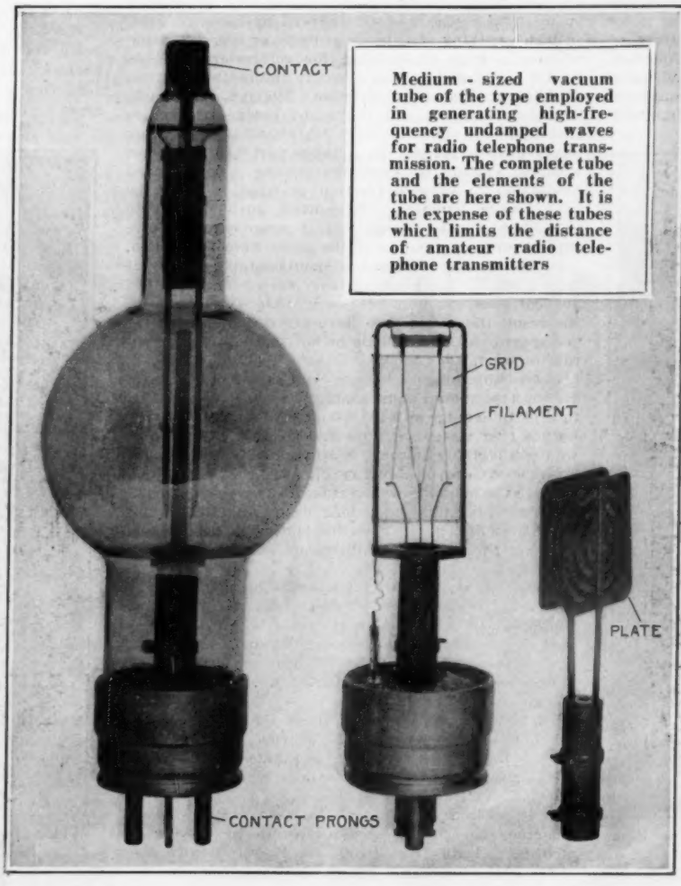
So arranged that an electrical oscillograph may be attached thereto, the apparatus serves the specific purpose of determining ejection velocities of each projectile fired from a ship. The oscillograph is composed of a high frequency, critically damped galvanometer arranged with an optical system whereby the galvanometer deflections are recorded upon a moving photographic film. Variations of the current through the galvanometer are reflected upon the photographic record at a negligible lapse of time. Each oscillograph is equipped with three galvanometers which can be employed independently. For example, during the firing on the U. S. S. "New Mexico," two, three or four oscillographs were used at the same time to record the measurements taken during the various naval salutes.

Such impressions, or oscillograph records, are taken on a photographic film 60 inches long by 3½ inches wide, conveyed on a drum 60 inches in circumference. Fastened to the oscillograph, the drum is in continuous rotation while the film exposure is being made. Operating electrically, the closing of one switch will energize electro-magnets which open the oscillograph shutter and close it again after the drum has made a complete rotation. The use of a film 60 inches long permits the the taking of an impression of sufficient duration to record the complete recoil and counter recoil of the gun without appreciably condensing the time scale. Three-eighths of an inch represents 0.01 second, an unit of measurement determined on the film. Likewise it is possible to record on a more open time scale the events which transpire while the projectile is in the gun than heretofore. In noting the impressions the speed of the film is described as being ⅜ of an inch, representing 0.001 second.

Insufficient intensity of light has hitherto been a retarding factor in determining the ejection velocity of a projectile. Consequently, the Bureau of Standards designed and constructed a special arc lamp whose beam of radiation is from six to eight times the intensity of the light reflected from the ordinary oscillograph arc lamp. The latter is made rigid by fastening both it and the oscillograph to a table. "Knockdown" tables are used in facilitating the handling of the apparatus and equipping a laboratory aboard ship, each unit comprising a switchboard and requisite switches for operating oscillographs.

A timing system, peculiarly adapted to the purpose for which it was developed, is grooved into each oscillograph, whereby the moving photographic film is ruled into equal time by allowing flashes of light from the arc light to fall upon it at specified intervals. A thin slotted aluminum plate is mounted on each prong of a tuning fork so that the plates overlap.

The fork is mounted in the oscillograph and the plates adjusted so that when the fork is not vibrating the slots are in line with a beam of light, an optical system first condensing the light from the arc upon the slot and then throwing it in a narrow line across the film. With the fork vibrating, the slots are in line with the radiation twice each vibration, thereby insuring twice as many flashes on the film to the second as the fork makes complete vibration during the corresponding time. These forks are driven by a 100-cycle master fork which carries two contacts. One is employed in driving the fork itself, while the other is connected in series with the magnet of the 500-cycle fork and a source of 110 volt d.c. power. The magnet of the 500-cycle fork is therefore energized 100 times per second or once every five vibrations of the fork itself. Careful tuning renders it feasible to drive the fork with a total amplitude of 0.06 inch. Considering that the slots are only 0.004 inch wide, the amplitude of vibration produces flashes of light of an infinitely brief duration—an examination of the film determining the time element of the flash not exceeding 0.00001 of a second.



Medium - sized vacuum tube of the type employed in generating high-frequency undamped waves for radio telephone transmission. The complete tube and the elements of the tube are here shown. It is the expense of these tubes which limits the distance of amateur radio telephone transmitters

Oil Shale in Palestine

ON the shores of the Dead Sea and west of that sea, between Jerusalem and the vicinity of Nebi Musa, is found a peculiar stone. The stone, which is abundant, is commonly used by the local people in making souvenirs. It is a matter of common knowledge that the Bedouins have used this stone for several years as fuel, and it is reported that during the war it was so used by the Germans. It is said that the latter also extracted oil from it. The stone is called Dead Sea stone and Stinkstein. In the Yarmouk Valley in northern Palestine are also found vast quantities of an oil-impregnated shale.

General view of the Savenac Nursery seed beds, Lolo National Forest, Mont.

Our Reforestation Activities

Some Facts and Figures About Tree Planting on a Gigantic, Yet Still Insufficient, Scale

By Charles Frederick Carter

NOW that a comprehensive program for forest conservation has been formulated for the first time and submitted to Congress as the "Snell Bill," a brief inventory of our forest resources today and a summary of the efforts now being made to provide for the needs of tomorrow should be of interest, although such a survey is hardly flattering to the National vanity.

It is now forty-eight years since Congress first took cognizance of the necessity for Governmental action to conserve the Nation's forest resources by the passage of the timber culture act of 1873; thirty years since the first forest reserve law, designed to protect the sources of streams, was enacted; and twenty-four years since recommendations of the National Academy of Sciences, submitted pursuant to request from Congress, were formulated into what then seemed an adequate National forest policy. All this time we have continued to squander our forest resources with the prodigal folly of the proverbial drunken sailor until at last we are confronted with the knowledge that they will be exhausted within a few years unless heroic measures are applied at once.

Figures from the National Forest Service fix the total original forest area of the United States at 822,238,000 acres, of which there remain approximately 463,000,000 acres of nominal forest. But only 30 per cent, or 137,000,000 acres is virgin forest. The rest includes 112,000,000 acres of second-growth saw timber, 133,000,000 acres of second-growth below saw-timber size and 81,000,000 acres which have been devastated by wasteful methods of cutting and by repeated fires, on which nothing of value is growing or likely to grow without a huge expenditure for reforestation. This totally devastated area is equal to the combined areas of France, Germany, Belgium, Holland, Denmark, Switzerland, Spain and Portugal. Besides the waste land there are approximately 245,000,000 acres bearing second-growth forest. In a large part of this forest wasteful cutting or excessive grazing have reduced production to a mere fraction of what it might be with proper handling. To convert such lands into valuable producing forests will, in many cases, involve expenditures as great as if the lands were devastated.

Of the meager remnant of merchantable timber at least 5,500,000 acres are cut over each year; and they are cut over much more closely than formerly with the result that after fires have killed out most of the young growth there is little or no chance for reproduction to start.

Destruction from various causes diminishes the visible supply even more rapidly than use. From 1915 to 1918 an average of 9,400,000 acres of forest land were burned over each year; and in 1910 and 1919 the area was considerably larger. Storms, too, take their toll, a single cyclone on January 27, 1921 cutting a swath through the magnificent forest on the Olympic peninsula 30 miles wide and 75 miles long, destroying 8,000,000,000 board feet of timber. Then the black pine beetle is destroying timber by the billions of feet in the Pacific Northwest.

Stated in another way timber is being cut at the rate of 26,000,000,000 cubic feet a year, or more than four times as fast as the new timber is growing; while that of saw-timber size is being cut and destroyed by fire, disease and insects at the rate of 56,000,000,000 board feet a year, or more than five and a half times the growth of such material.

In view of such facts as these, efforts to conserve what timber is left and to provide for the future assume a lively interest; for the physical and economic well-being of everybody is intimately associated with adequate forest resources.

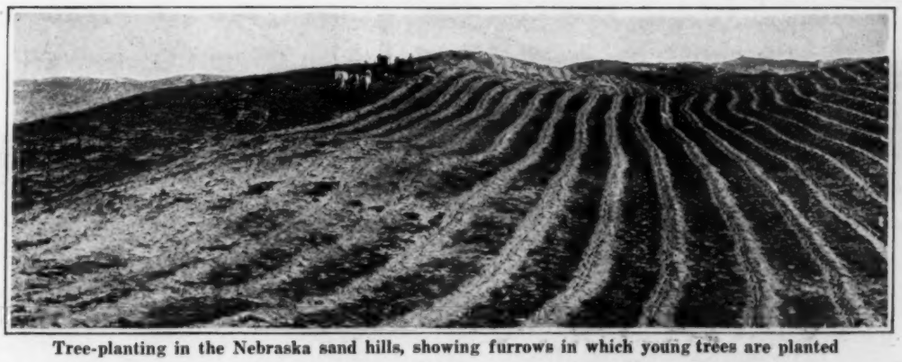
It is, perhaps, only natural that the uninitiated should imagine that forests would have to be restored by planting. Data from the U. S. Forest Service show that a total of 170,000 acres have been planted by the Service up to the end of June, 1920; 85,000 acres additional by the State Forestry Departments, and 350,000 acres by private individuals and corporations in 19 states. Adding the estimated planting in Nebraska, Kansas, Illinois, the Dakotas, Missouri, and Oklahoma would swell the private planting to a total of 750,000 acres, or a little more than a million acres planted by all the agencies that have been operating in this field in the United States, from the time when planting was first undertaken by the western settlers forty or fifty years ago, right down to the present time.

The Snell Bill appropriates $1,000,000 yearly for five years for reforesting denuded lands in the National Forests. As the average cost of planting is $10 an acre, this would provide for the reforesting of 100,000 acres a year. This is regarded as the maximum practi-

Planting crew setting out yellow pine, Pike National Forest, Colo.

White pine plantation 22 years old, on bare sand in Rhode Island for reclamation purposes

cable program by the National Forestry Program Committee representing professional foresters and a large number of organizations interested in forest conservation, although an ideal program would be 1,000,000 acres a year carried on uninterruptedly for 81 years. To reforest the 81,000,000 acres of hopelessly denuded land which should be growing timber both because it is needed and also because this land is fit for nothing else would require at the rate provided for in the Snell Bill 810 years and an original outlay of $810,000,000. Now about 130 years are required to produce good merchantable saw-timber, and 30 to 40 years to produce pulp wood. If compound interest be computed on the capital required for such an undertaking for 40 to 130 years the unsophisticated may begin to understand why tree planting as a process of restoring forest lands is relatively a minor matter in the minds of foresters. A forester never plants trees if he can get Nature to do it for him. Furthermore, Nature, if given half a chance, will usually do it. Planting is the most expensive method of establishing a new stand of timber. It involves a relatively high initial investment which must be carried at compound interest during the entire period required for the timber crop to grow to merchantable size and to be harvested. When it is remembered that the 81,000,000 acres referred to as utterly denuded is but a fraction of the total acreage requiring attention it will readily be seen that something besides planting is required if the country is to have a timber supply at all commensurate with its needs a few years hence.



Tree-planting in the Nebraska sand hills, showing furrows in which young trees are planted

That something is fire protection. According to a statement by Col. W. B. Greeley, Chief Forester, of the U. S. Forest Service, 39 States contain approximately 325,000,000 acres of timbered and cut over land in State and private ownership requiring protection from fire, which is the first step toward providing a continuous supply of timber. Of this area 175,000,000 acres are almost wholly unprotected. There are from ten thousand to twenty-five thousand forest fires every year which destroy the young forest growth on eight to ten million acres every year, aside from large areas burned over annually of which no record can be obtained.

Effective protection of these 325,000,000 acres of forest land, according to Col. Greeley, lies at the bottom of any National policy of reforestation. Once this vast area is really protected from forest fires, three-fourths of our timber supply problem will be solved.

Since 1911 the U. S. Forest Service has cooperated in fire protection work in 10 to 25 States, expending from $40,000 to $125,000 per year of Federal funds. In that period State and county expenditures have increased from about $250,000 a year to more than a million dollars while private expenditures have increased six or eight fold.

The cost of protecting forest lands from fire as reported by 26 States averages 2½ cents an acre. A forest protection budget for the United States, excluding National forests, would thus aggregate about $8,125,000 a year, whereas the sums regularly available aggregate $1,885,000, of which State and county appropriations represent $1,060,000, private expenditures $700,000 and the Federal appropriation $125,000. In other words, only about 25 per cent of the necessary task of protecting forest lands from fire is being done today.

"Forest fires, particularly those caused by lightning," said Assistant Forester E. E. Carter, "can not be entirely eliminated, nor can man-caused forest fires be eliminated any more than can man-caused fires in cities. In its essentials the problem of forest fires differs only in degree from the problem of man-caused city fires. The first essential is the recognition by every one of the danger and of the community loss from forest fires. The second is an organization to put out those which do occur while they are yet small. In some regions recognition of the serious loss to the community as well as to the land owner resulting from forest fires has not been developed. As a result fire fighting is more costly than will be necessary after the public is aroused. In some of the Western National forests a smaller force is now needed for fire protection just because the local public has acquired a more enlightened point of view regarding forest fires and has acquired the habit of being careful while in the woods.

"Forest fire protection, in my judgment, will reforest or keep cut-over land growing forest on hundreds of acres for every acre that has been or is likely to be reforested by planting. If fire protection alone will not restock the land with a new crop of trees a new crop can in many places be secured by leaving seed trees or in some types of forests by leaving the smaller trees when the mature crop is cut. Planting will have to be resorted to to reestablish forests on areas so badly burned or ruthlessly cut that a new crop can not be obtained by natural seeding.

"Part of the 81,000,000 acres so devastated by reckless cutting and by fire that it is no longer productive will have to be planted. Fire protection alone will restore the remainder. There will be little excuse for extensive planting outside these devastated areas. The exceptions will be where the need exists of securing quick indirect benefits such as the prevention of erosion, or in the Nebraska sand hills, or where local economic conditions justify extra expense to assure full stocking quickly."

The Snell Bill appropriates $1,000,000 a year for fire protection in cooperation with States and through them with private agencies. In the Pacific Northwest there are some thirty organizations of timber owners cooperating with each other and with the State and Federal Governments in fire protection. In Oregon and Washington laws have been passed making patrol of privately owned timber lands compulsory. Private contributions sometimes amount to as much as 20 to 30 cents an acre a year. The private owners also take care of a large proportion of denuded and restocking lands, regardless of whether it belongs to them or to the Government. In this territory natural reproducton is swift and sure if fire is only prevented from undoing what nature so laboriously accomplishes.

The Snell Bill also appropriates $10,000,000 a year for 5 years for acquiring additional lands for National forests, which on June 30, 1920, aggregated 156,032,053 acres and which are intended to be conservation areas as well as a protection for waterheads. The Bill appropriates a grand total of $71,250,000 distributed throughout a term of five years, the purpose including, in addition to those already mentioned, a survey of the forest resources and timber requirements of the Nation and forest research, investigations in wood utilization and a study of forest taxation, the effort being to distribute fairly the other forest expenses as well as the forester's share of ordinary governmental expense.

Among the States New York leads in reforestation. Not only does the State produce about 5,000,000 trees a year for reforestation, but paper mills and railroad companies maintain their own nurseries. From 1908 to 1920 the State planted 60,000,000 trees, which at the usual average of 1,000 trees an acre means 60,000 acres replanted. In 1920 the State planted approximately 8,000,000 trees while private owners planted 3,000,000 trees on cut-over land.

Massachusetts has been carrying on an active reforestation program for several years. Recently the State acquired 100,000 acres to be restocked as rapidly as nursery stock can be grown.

In the South, Louisiana leads in reforestation. A single lumber company has planted 3,000,000 trees. The lumber companies have united in conducting extensive educational campaigns in the schools. The State Department of Conservation has just started a competition for boys' clubs in planting and caring for trees. Texas is not far behind Louisiana.

Michigan planted 4,000,000 trees on State lands in 1920. Minnesota has done some reforestation, but the principal activities of the State have been in fire protection. Kansas and Nebraska have done considerable planting to check drifting sands in the West and the work has been notably successful. Florida, Missouri, and Ohio have recently enacted laws providing for reforestation. Most of the other States have done or are preparing to do something in the way of reforestation, but not yet on a scale large enough to be really effective.

Broadcast seeding on high ridges in the wake of forest fires, Olympic National Forest, Washington

Oriental Demand for American Lumber

JAPAN imported 77,000,000 feet of American lumber in 1920, according to a report appearing in the *Japanese-American Commercial Weekly*. A material reduction in prices, a decrease in freight rates, and the recent great fires in Japan are considered grounds for the belief that this demand will increase to about 100,000,000 feet in 1921. While the normal export of lumber to China amounts to about 200,000,000 feet annually, that of 1920 came to only 155,000,000 feet, though greater activity is expected in this market this year. A striking difference between the trade with Japan and China lies in the fact that while the former country buys practically all lumber for remanufacture, the latter imports lumber in manufactured form.

Left: A glimpse of the phosphate fields of the Mountain States, which latest Government surveys estimate to contain more than six billion tons of high-grade rock. *Right:* Phosphate mine in Florida, the state which has always supplied the bulk of the rock used in fertilizers

Phosphate resources of the United States

Phosphorus, the Backbone of Life

America's Great Deposits of This Chemical for Fertilizers and Through Them for Food

By George H. Dacy

DESPITE that the United States includes within her borders the greatest phosphate mines in the world, we have failed lamentably up to this writing in making the most efficient and effective utilization of these valuable mineral deposits. True, subsequent to the Civil War—it was in 1862 that the phosphate deposits in South Carolina were first discovered—we began to develop our phosphate resources and extended the industry gradually to Florida, Tennessee, Arkansas, Kentucky, Utah, Idaho, Wyoming and Montana, but in the mining and utilization of this natural heritage we have pursued extravagant, wasteful methods. In some instances as much as two-thirds of the phosphate which is mined is washed away onto the dump piles in order that the marketable product may be of the finest grade and quality.

Fertilizer economists, of course, argue that the washings and tailings which are run out on the dump heaps are not legitimate wastes until some practical method is devised of separating the mineral from its impurities. Albeit, if these phosphatic losses are compared with those occurring in the mining and smelting of metalliferous ores, they appear little short of rash folly. Metallurgical practice has now been developed to a stage of perfection which admits of working over old dump heaps and tailings containing only a fraction of one per cent of the desired mineral with economic success. From an industrial standpoint, it therefore is criminal that material and byproducts containing from 12 to 18 per cent of marketable phosphorus should be heedlessly thrown away just because the ingredients are relatively low-priced.

The manufacturer of iron or steel would hardly conceive of a condition where his finished product would contain less of the marketable ingredient than the ore from which it is derived; while to ship and reship material from place to place under conditions of almost prohibitive freight rates while the percentage of its valuable ingredient was constantly being decreased would appear like industrial suicide to the average layman. Nevertheless, that is exactly what is done in the phosphate industry, an industry which is the backbone of the fertilizer business and the fundamental basis of the agricultural wealth of a considerable portion of the Eastern and Southern States.

After the high-grade phosphate rock is recovered as a result of elaborate washing and screening processes, it is shipped ong distances to fertilizer factories, where it is treated with an approximately equal weight of sulfuric acid and manufactured into acid phosphate which ordinarily contains about 16 per cent of phosphoric acid—less than 50 per cent of the amount contained in the original rock as it comes from the phosphate mine. Thereafter, this low-grade shipped long tilizer - mixing farmers — the The purchasers are obliged to bor and han- 84 per cent of ficial filler in fertilizer. By fertilizer is fited over the over - worked costs have aquite a sum. scientists adsity for dilutted phosphatic fore they are for farm crops, tend that it is and wasteful purposely to low-grade goods points of conthe filler of could just as to the original material on the products are

Apparatus for the electric precipitation of phosphoric acid

product is again distances to ferplants or to the ultimate users. of this fertilizer pay freight, ladling charges on natural or artithis commercial the time the nally distribusick, ailing or fields, these gregated to Agricultural mit the necessing concentrafertilizers beused as a tonic but they conan unnecessary extravagance manufacture far from the sumption when diluting agent well be added concentrated farm where the used.

Every effort of the national Department of Agriculture and the various state agricultural agencies is—at present—directed toward the reformation and standardization of the phosphate mining and manufacturing business so that hereafter phosphoric acid may be marketed with the least possible waste of time, money and material. Some prominent phosphate plants have already been re-adapted to these new and economical practices. Instead of marketing the traditional varieties of 16 per cent acid phosphate, they are distributing products containing up to 50 per cent of phosphoric acid. One concern has placed on the market a compound of ammonia and phosphoric acid which contains large enough amounts of these two fertilizing elements to permit of its economical transportation to far distant points.

An enormous loss of valuable phosphatic materials annually obtains in the Florida mines which market about 2,000,000 tons of phosphatic rock a year. Heretofore, from 50 to 65 per cent of this supply of phosphatic acid was wasted due to insufficient methods of separating the impurities from the valuable fertilizing mineral. Uncle Sam, through the experiments and investigations of his Bureau of Soils, has demonstrated recently that this great loss of phosphate entailed in mining Florida rock may be largely eliminated by mixing the "run-of-mine" phosphate with sand and coke, and smelting the mass in either an electric or a fuel-fed furnace. In this process the phosphoric acid is driven off as a fume and may be readily collected in a concentrated form. Although additional research work must be instituted and completed before all the minute mechanical and chemical details have been solved satisfactorily, the operations bid fair to prolong the life of our phosphate deposits for an indefinite period.

According to the most recent surveys and estimates of the U. S. Geological Survey, the phosphate fields of Utah, Idaho, Wyoming and Montana exceed in tonnage the total output of all our other fields. The government experts figure that these new deposits contain more than 6,000,000,000 tons of high-grade phosphate rock as well as many times this amount of low-grade phosphates. Not only does this country own the largest phosphate deposits in existence but we also mine and manufacture more of this fertilized material than any other country. In addition to supplying our domestic needs, our native mines also export anywhere from 500,000 to 1,000,000 tons annually. A considerable part of our annual production is ground finely and applied over agricultural fields in that form but the vast bulk of the rock is treated with sulphuric acid and converted into acid phosphate, the foundation of commercial fertilizers.

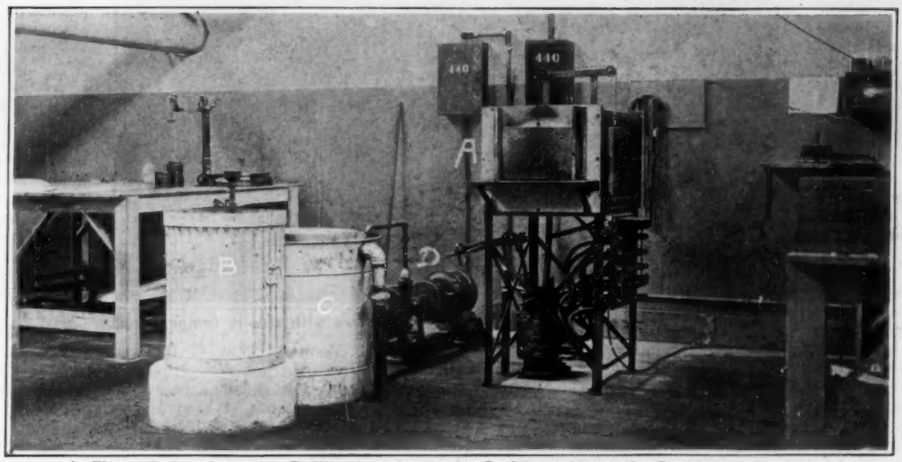
Small test furnace in which mixtures of phosphate rock, sand and coke are smelted at high temperatures, and the phosphoric acid distilled out and collected

Why Weary Metal Fails Under Light Loads

The Causes of Steel Fatigue, and the Ticklish Problem of Testing Against It

By George H. Dacy

A MOTOR truck accustomed to handling loads of six to ten tons may collapse due to axle failure when the only burden the machine is carrying is the driver. A street car which handles 100 passengers during the peak traffic hours of the day may wreck due to axle or wheel collapse when it is returning to the car barn to be greased. An elevator which is adapted to carry 20 persons may crash to its basement pit when empty. Even bridge girders which have been designed to support enormous stress and strain may break down under light loads. Not infrequently serious automobile, street-car, elevator and bridge accidents occur which result in heavy losses in limb and life just because some of the metal parts used in the construction of the vehicles or bridges have become so tired that—without warning or outward evidence of portending collapse—they give way. These untoward phenomena for years have presented perplexing and puzzling problems to the engineering fraternity, which has done everything possible along technical and scientific lines to reduce the risk and solve the riddle connected with metal fatigue.



A—Electrically-heated furnace. *B*—Water-quenching tank. *C*—Oil-quenching tank. *D*—Oil-circulating pump

Laboratory apparatus for reproducing the conditions of heat treatment

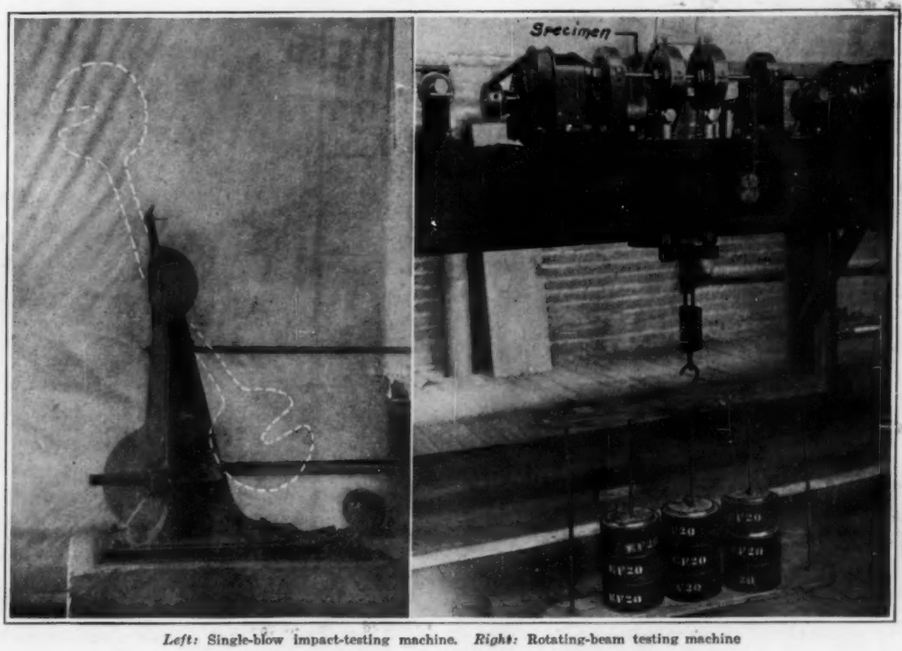
Under the joint auspices of the Engineering Foundation, the National Research Council, the General Electric Company, and the University of Illinois Engineering Experiment Station, invaluable investigations are being conducted at Champaign, Ill., over a two-year period to ascertain accurately the limit of endurance of a wide range of samples of iron and steel. Heretofore, frequent experiments have been carried out to determine metal durability under the strain of a single load. The purpose of the current investigations is to find out conclusively about fatigue strength under frequent loadings. Novel and unique testing machinery, which under laboratory conditions over a short period submits the metal materials to stress and strains such as they would be exposed to during many years of service usage, has been designed expressly for the purpose of clearing up the intricacies which, previously, have obscured the engineer's knowledge concerning the everyday history of steel and metal materials and their reactions to continuous service.

A modern Goliath of professional weight-lifters for many years may excel all his rivals in remarkable feats of strength. Then due to excessive use of certain muscles or on account of old age, he may begin to slow up; his muscles are unable to respond so adeptly to the dictates of his will. He has to reduce the weight of his dumb bells, bar bells and cannon balls. Gradually, he fails in health and strength and ultimately, he is obliged to abandon his exhibition work. Now unlike the human metabolism, the strength of metals gives way all of a sudden without any indication of impending failure. The line shaft in a machine shop may have been in active service only a few years and appear as good as new—yet, unexpectedly, it may fail and cause a costly and serious accident. Similarly, the steering knuckle or crankshaft, springs, axles or engine parts of the motor car apparently may look fit and strong yet under service when the driver least anticipates a breakdown, one of these parts may disrupt. That is why the need is urgent for some method of standardized testing which will admit the prediction of the actual use and strain which the different metal materials will survive. Vital statistics are needed which will forecast the lifetime of steel and iron so that approaching failures may be noticed and guarded against.

Studies of why metals under light loads, frequently repeated, failed more rapidly than they did under heavier burdens of a more uniform pressure have been in progress for the last 60 years. German scientists conducted many tests and devised methods which are incomplete when measured in terms of modern machinery, mainly because they are of such short duration and because since those tests many new kinds of steel have come into use and new metals such as aluminum are available for building machines. The inadequacy of these investigations led to the conception of the series of strength tests devised by Professor H. F. Moore and his talented assistants. Any metal that survives these tests merits a distinguished service cross denoting special strength superiority. These middle western engineers have devised tests which expose the metal samples to every conceivable stress and strain under regular repetitions.

Metals while being subjected to fatigue in these experiments have been observed under the microscope and it has been found that the crystals of which a metal is composed will allow deformation to occur by movement along certain gliding planes within the crystal. This gliding or slipping is indicated by the appearance of lines running across the crystals. They are called "slip bands" and careful examination has elicited the facts that the slipping causes microscopic ridges and depressions of the surface, in the nature of steps. As the test of the material fatigue is continued, the slip bands become more numerous, and also broaden. Finally, some of the bands develop into a crack which spreads to other crystals and thus causes failure. Therefore, it appears that the primary cause of fatigue failure is localized deformation. Because steel is composed of many minute crystals—in ordinary steel there are at least two different kinds—the structure is not likely to be homogeneous. Furthermore, there are likely to occur many microscopic flaws throughout the material. Hence somewhere in the sample, there will be high local stresses due either to non-homogeneity or to flaws, and at such points, the sample will be liable to deteriorate by the repeated action of fatigue stresses. The presence of internal stresses, due to previous heat treatment or mechanical treatment, would also tend to weaken the material when fatigue stresses of a similar character are applied later.

The Illinois experiments feature the repeated stress of steel under regular repetition and are accompanied by very careful static tests, impact tests, and special magnetic tests. An endurance limit of 100,000,000 cycles or repetitions was decided upon and it has been determined that every sample which survives this strength is adequate for the most rigorous field service. To illustrate the severe wear to which the metal parts are exposed in actual service—it is worthy of note that in the case of a steam turbine rotating at a speed of 3,000 revolutions a minute, the shaft suffers a reversal of bending stress every revolution. The average life of a steel turbine blade is 10 years during which it is exposed to something like 15,000,000,000 such bending strains. Under such service, any flaw or defect is sure to show. As a result of these new experiments, henceforward, it will be possible to locate these defects in the testing laboratory before the turbine blade is made. The approximate number of repetitions of stress in the normal lifetime of the following structural and machine parts are: railroad bridge, chord members, 2,000,000; elevated railroad structure, floor beams, 40,000,000; railroad rail, locomotive wheel loads, 500,000; railroad rail, car wheel loads, 15,000,000; air-

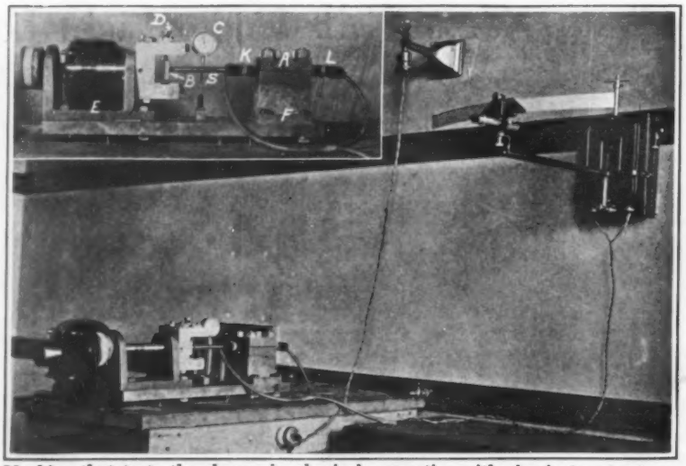


Left: Single-blow impact-testing machine. *Right:* Rotating-beam testing machine

Some of the apparatus that induces weary steel to tell its story

plane engine crankshaft, 18,000,000; car axles, 50,000,000; automobile engine crankshaft, 120,000,000; line-shafting in shops, 360,000,000 and steam engine piston rods, connecting rods and crankshafts, 1,000,000,000.

Professor Moore has been working to perfect a commercial method for predicting the fatigue of different steels and irons and in this research work he is testing out all the related laboratory methods and laws. From each sample of steel, he machines 20 specimens each of which is .4 inch in diameter and 13 inches long. Some of the samples are first submitted to physical tests which subject the steel to stretch and deformation tests and under stretching pressure of 10,000 or 12,000 pounds or whatever amount is required stretch the steel sample out like taffy candy until it "necks down" and finally breaks. The heaviest, steady load test machine in use in the Illinois University laboratories has a capacity of 600,000 pounds. A special, electrically driven machine with a backward and forward vibration is so equipped with heavy springs that the amount of compression is recorded by a special attachment in graph form indicative of the repetition strength of the sample under vibratory strain.



Machine that tests the change in physical properties with rise in temperature

A battery of 15 stress machines of the rotating beam type—really facsimiles of a freight car axle upside down—are so arranged that every rotation of each machine reverses the stress on the sample which is being tested on it. The steel sample is inserted like an axle in this machine and is rotated at the rate of more than 2,000,000 revolutions a day. These test conditions duplicate closely those of the ordinary railroad car or automobile axle in motion. Each test is continued for 45 days when the samples will have been exposed to 100,000,000 repetitions of stress. Samples that withstand this modern, mechanical, torture chamber successfully are qualified as "endurance satisfactory" for the purpose intended. The arrangement is such that if the sample collapses before the completion of the test, an electrical connection is broken automatically and the machine stops. A special counter is used on each machine to record the number of revolutions. The experiments have demonstrated the general fact that if the steel samples do not fail by the time they make 10,000,000 revolutions, they will survive the strength test of 100,000,000 rotations on the machine; and so far as can be predicted from the test results, will survive an indefinite number of repetitions of stress.

"The action upon the steel in the testing machines is in the nature of a constant backward and forward bending motion," reports Professor Moore. "For example, a wire will bend double once without breaking but if you wiggle it back and forth a few times, it invariably will snap. When a car axle stands at rest, the upper portion suffers tension from the weight sustained at each end. Simultaneously, the lower surface is being exposed to compression or crushing action. If the axle is rotated a half turn, this condition of the wheel sections is reversed. In a word, the wheel is undergoing the same action as that which snapped off the wire—a much severer test than to support a single, stationary load. The microscope shows that a peculiar action occurs in the internal structure of the steel during this process. After repeating stress, steel will snap almost without any warning; while under a single heavy load, it will crumple. In the former instance, the steel behaves as though it were a brittle instead of a ductile metal."

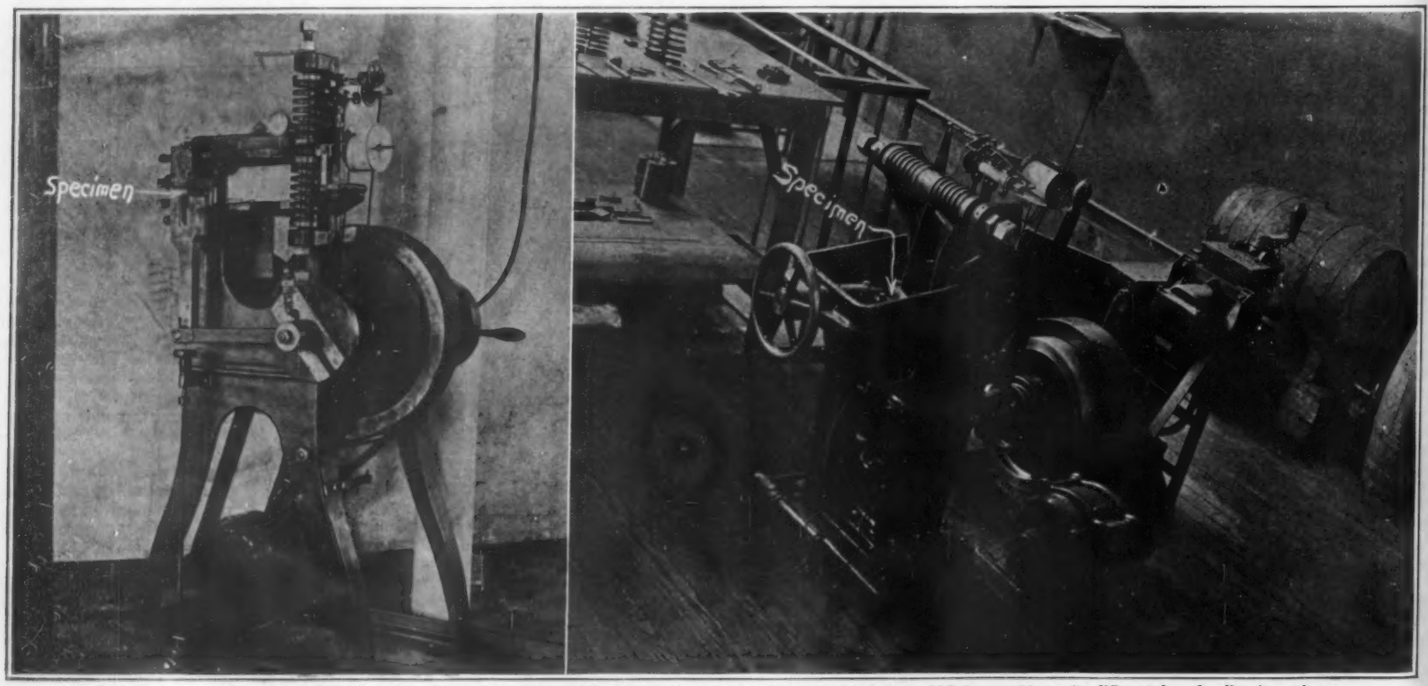
A peculiar pendulum-like hatchet is the outstanding feature of another testing machine which is used to subject the steel samples to abrupt and rapid shock and jar. A small notch is cut in the steel rod which then is placed in position so that it will receive the full impact of the pendulum as it completes its swing through an arc of 160 degrees. Special records are kept of the breaking strength of the steel rods in this test. Another repeated impact machine is so adjusted and mounted that it hammers the test samples first on one side and then on the other. Another sensitive machine is equipped with a microscopic arrangement so that it registers very slight deflections of the steel under delicate pressure. However, these tests under heavy, sudden impact do not seem to give any reliable index of the ability of the steel to withstand millions of repetitions of light loads. One of the purposes of the extensive investigations under the direction of Professor Moore has been to devise a short cut, abridged system of testing steel samples which is efficiently adapted for general utilization in commerce and industry.

The principles of this new test were suggested several years ago by an English engineer named Stromeyer but the infallible reliability of the test and methods for its most efficient performance have been worked out at the University of Illinois. The machine for making the new test is inexpensive. It can be applied, in some cases, to machine parts which are to be used in actual service, as the test does not injure the specimen tested. It may be possible to test an automobile crankshaft, an elevator wire rope, a bridge girder, a car axle or a railroad rail before these respective parts are installed.

It has been found that if under repeated loading, incipient cracks begin to form, then the formation of these cracks is accompanied by a very slight rise in temperature—a small fraction of a degree. This rise of temperature occurs in a minute or two after the repetitions of stress have begun. The proposed test for "fatigue" developed at Illinois University is in effect the application of a clinical thermometer to a steel specimen to which repeated stress is applied.

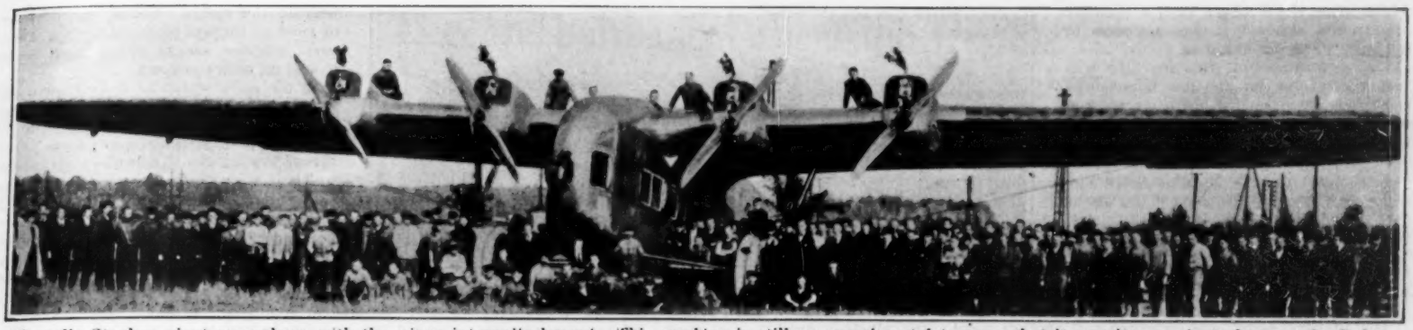
A vise is used which holds one end of a specimen, and an adjustable eccentric which "wobbles" the other end of the specimen by any desired amount. A micrometer is used to measure the amount of "wobble" which determines the amount of stress applied. The "clinical thermometer" used is really a delicate electric thermo-couple which is held against the specimen at the point of maximum stress. In turn, it is connected to a delicate galvanometer whose readings measure the temperature developed, even though it be as minute as one one-hundredth of a degree. If the test shows no development of "temperature," the "wobble" is increased and another run made. In fact this program is continued until a decided development of "temperature" is shown. The stress corresponding to the "wobble" which causes this rise of temperature is the "endurance limit" for that particular steel.

The "endurance limits" determined by this rapid "rise of temperature" test have been checked by comparison with the endurance limits obtained by the slow, tedious experiments on the rotating beam machines, and the correspondence of values is very satisfactory.



Left: Testing apparatus for repeated bending. *Right:* The machine that subjects the test piece to repeated twisting, which is something quite different from bending in a plane

Putting steel through the acid test of long repeated stress of the same sort



Zeppelin-Staaken giant monoplane, with the wings internally braced. This machine is still an experimental type, so that its merits remain to be proved. It has out-board engines—four 260-horsepower Maybachs

The Revival of the Monoplane

Reasons Why This Type, Once Replaced by the Biplane, Has Again Become the Favorite

By Ladislas d'Orcy

SIX years ago the writer pointed out in these columns* how certain requirements of military aeronautics had, early in the war, brought about the elimination of the monoplane type of flying machine. In fact, it may be said that in a general way the war in the air was fought and won with biplanes, the few exceptions to the rule—Morane-Saulnier and Fokker monoplanes, Sopwith triplane, etc.—being hardly worth the mention.

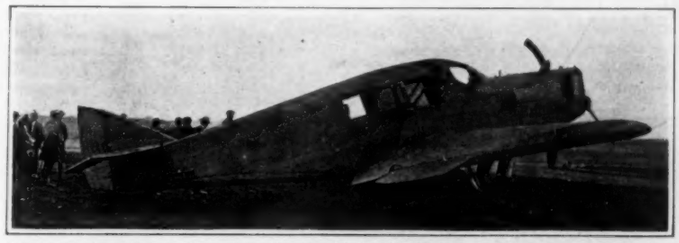
But today we are witnessing a strong revival of the monoplane in this country as well as abroad. What are the reasons for this latest development? Is this only a passing phase, a designer's fad, one is tempted to say, or has the monoplane come back to stay? And will it in its turn supplant the biplane and the triplane?

To give an adequate reply to these questions it is first necessary to make clear a fundamental point in aerodynamics.

For the same area a monoplane wing, or single-decker, is and always will be more efficient than any combination of superimposed or following wings, because the latter mutually interfere with their progress through the air. By this is meant that while in a monoplane the air stream which the wing sets up in its path escapes freely, in a biplane, for instance, two such air streams are created which constantly collide. As a result a biplane wing combination lifts only about four-fifths the weight a monoplane of the same wing area is capable of supporting.

This theory was as well known in the early days of aviation as it is today. Yet about 1914 the design of tractor biplanes had made such progress that it became extremely difficult to build monoplanes of equal if not of superior efficiency. This may sound peculiar in view of the greater theoretical efficiency of the monoplane wing, but the fact of the matter was, as it so often happens, that theory and practice were at considerable variance.

To begin with, a tractor biplane could be built with wings trussed on the Pratt or the Warren principles, so that the question was merely one of suitably applying the principles of bridge construction. With the monoplane the problem was not so easy to solve, for here the single wings had to be braced on the king-post principle to the center line of the machine. As the engines then available were of low horsepower, the construction of airplanes had to incorporate extreme light weight, which limited the proportions of the fuselage to a narrow girder work. This was not deep enough to afford suitable points of attachment to a rigid truss, and therefore the wings had to be braced by wires to steel pyramids built up above and below the fuselage. As a consequence an undue amount of head resistance was created, and it became impossible to derive from the monoplane arrangement the efficiency which theory showed it to be endowed with, on aerodynamic principles alone.



Junkers six-seater cabin monoplane, which afforded the first practical solution of the internally trussed, strutless monoplane. Engine: 230-horsepower B.M.W.

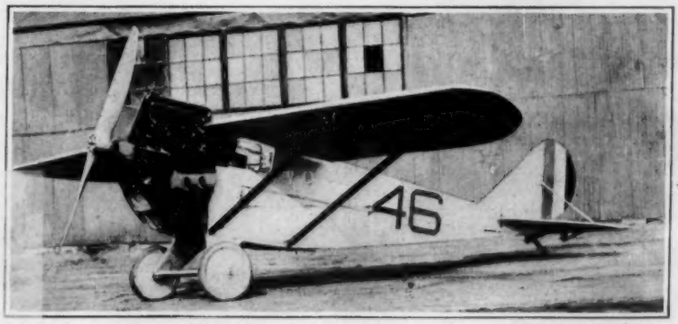
From the military viewpoint, also, the monoplane seemed less desirable than the biplane, because the pilot was seated in the centre of the wings, where he possessed little vision downward, although his vision forward and upward was excellent. Hence it is small wonder that the monoplane lost for many years the favors of aeronautical engineers and pilots.

Morane monoplane, typical of pre-war construction, used in training American pilots in France. Engine: 60-horsepower Anzani

But as soon as improved methods of construction were devised, chiefly as the result of the advent of more suitable materials, and more powerful engines were successfully produced, the question of the monoplane came once more to the fore. Toward the end of the late war the tractor biplane had been developed to such a high degree of efficiency that improved performance could only be expected from higher horsepower or from wing sections giving greater lift. Hence it is natural that aeronautical engineers should once more have turned their attention to the monoplane. If this type could be built in such manner that its parasite resistance (*i. e.*, the resistance of those portions of the structure which do not contribute to sustentation) were no greater than that of a biplane, the monoplane would obviously be the more efficient of the two types, because for the same wing area its lifting power would be greater. If, furthermore, the parasite resistance of the monoplane could even be reduced below that of a biplane, the former would score so much the heavier.

Experiments along this line of thought came to a head in 1918 with the appearance of an American machine, the Loening fighting monoplane, a slightly modified model of which is shown below. The tests of this machine were a revelation with respect to the possibilities of up-to-date monoplane design. Although carrying two men with the military load of a two-seater fighter-observation airplane, the Loening monoplane showed a performance comparable with that of the best single-seater pursuit machines of its day. The answer to this revelation was that in the construction of this machine the parasite resistance was reduced to a minimum, owing chiefly to the bracing system, which consisted of four streamlined steel struts. The problem of visibility, on the other hand, was solved by fitting the wings flush with the top of the fuselage and by letting windows in the side of the fuselage, through which the pilot could well see the ground. The vision upward, of course, remained as good as it ever was in a monoplane.

A further advance in the efforts tending to make the monoplane more efficient was accomplished in the German Junkers monoplane which came out after the armistice. While the Loening monoplane achieved its notable performance with orthodox systems of wing and fuselage construction (wooden framework and internal wire trusses), the Junkers machine incorporated some radical innovations. Coming to the logical conclusion that external trusses are the main source of parasite resistance, the designer of the Junkers decided to build the wings on the cantilever principle, so they would carry the flying loads as beams. At the same time he adopted duralumin to the exclusion of all other materials both for the structure and the outer skin. The framework of the Junkers monoplane is built up of duralumin tubing, while the covering consists of corrugated duralumin sheathing. As a further innovation the wings were mounted flush with the bottom of the fuselage,



Loening monoplane, which originated the modern tendency of bracing the wings with rigid struts instead of with wires. Engine: 300-horsepower Wright-Hispano

* See SCIENTIFIC AMERICAN, Sept. 4, 1915: "How the War Has Modified the Aeroplane."

which gives the Junkers such a peculiar appearance, although it does not seem to influence its flying qualities.

The performance of this machine was very remarkable for the low horsepower employed, but extended operation showed up a number of flaws which were to be anticipated in an experimental type of such unorthodox nature. Owing to the exclusive use of metal in the construction of the fuselage, the vibration of the engine was transmitted over the entire body, causing crystallization. Thus cracks developed in the covering of the fuselage. On later models this drawback appears to have been overcome by mounting the engine on ash bearers to absorb vibration.

Fokker six-seater cabin monoplane. Note the position of the wings, on a level with the top of the fuselage, so as to clear the body

The Junkers' monoplane embodied still another novel principle, that of utilizing the metal skin for structural strength. This principle is open to objection in that the strength of the machine may be greatly reduced if the outer skin is injured, even if this is not visible, such as in the early stages of crystallization. It is understood that the latest Junker machines are no longer built on this principle, the framework alone being now capable of withstanding the stresses developed in flying.

Another interesting solution of the internally braced monoplane is afforded by the Fokker cabin machine illustrated, which is extensively used on the European airways. In this machine the fuselage is built of welded steel tubing, which is covered with veneer in front and with fabric in the rear, while the wings are entirely built of wood, including the covering, which is of veneer. The wings are flush with the top of the fuselage, the designer being evidently of the opinion that aerial travelers prefer to look down on the ground rather than skyward—which practical experience appears to bear out. The Fokker cabin monoplane has given a very good account of itself in operation. The pilot is seated in front of the wings in an open cockpit where he has an excellent view of both ground and sky, and from where he can also keep an eye on the engine.

The three examples of modern monoplane construction we have dealt with may be said to have opened a new era in the design of airplanes. They have conclusively proven that in so far as single-engined airplanes are concerned the monoplane is not only theoretically but also practically more efficient than the biplane. While it is true that at present the wing structure of a biplane weighs less than that of a cantilever monoplane, this is merely a passing phase due to less experience in the construction of the latter.

Regarding multiple-engined machines, the situation is not quite so clear. There are some grave objections against twin-engined airplanes in which the engines are mounted outboard and efforts are now being made to solve the problem of a central engine room containing several power units, a portion of which would keep the machine in flight should one of the engines fail. When this problem is solved—as it must be sooner or later—the monoplane will probably still appear to be the most desirable type, just as it is today for use with the single-engined power plants of present practice.

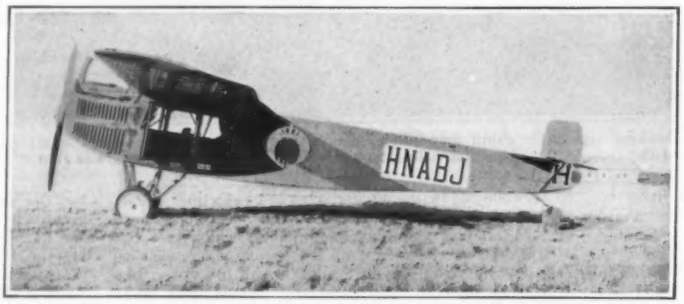
An attempt worth mentioning at a multiple-engined monoplane is the Zeppelin-Staaken giant machine. In this airplane, which is built to carry twenty persons, the four engines are housed in the depth of the wings, and a passageway is fitted in the latter to enable a mechanic to adjust the engines in flight. Although this machine has made several successful flights, it is still in the experimental stage, and adequate comment is therefore impossible.

Resuming, it may be said in reply to the questions which head this article that—

(1) The revival of the monoplane is due to improved methods of construction which make it more efficient than the biplane;

(2) The monoplane is likely to become the standard type of small and medium sized flying machines up to the highest power of a single engine;

(3) Insofar as large multi-engined airplanes are concerned, the monoplane type seems chiefly restricted by considerations of encumbrance (difficulty of housing, need of large fields) so that biplane, and even triplane, construction will likely survive in the very large types.



Fokker six-seater cabin monoplane: another solution of the internally-braced monoplane. The engine is a 240-horsepower Siddeley "Puma"

Difference Between Molds and Wood Destroyers

NOT all fungi which live upon wood impair its strength, but conditions which promote the growth of molds, blue-stain fungus, and other non-injurious fungi are usually favorable to the growth of the wood destroyers, and these may be active on the same wood bearing the molds. Hence, the presence of mold on timbers intended for any structural purpose should cause them to be looked on with suspicion.

In the early stages of their growth the molds and the wood destroying fungi sometimes have a very similar appearance, and there is no simple means known to the Forest Products Laboratory by which lumbermen and wood users can separate them at sight. The surface growth of molds is generally cottony or felty in appearance; the mycelium or fine mold threads are interwoven, never compacted into membranous sheets or strands. The mycelia of wood destroyers may be fluffy and glistening, but more usually are compacted into strands or fan-shaped patches.

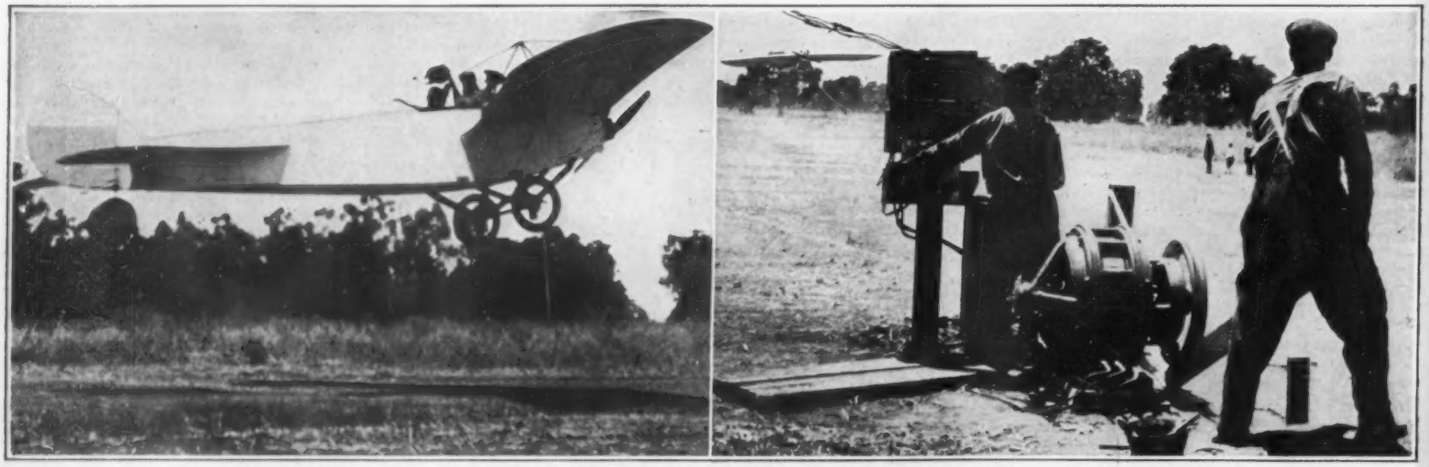
The characteristic feature of mold growth on wood is the fact that the minute threads which enter the wood do not bore into the wood fibers or dissolve them away. They pass through the spaces between the fibers or enter them through the natural openings, called pits, which are found in the walls of certain cells. Starches, sugars, and other contents of wood cells constitute the food of the molds.

The wood-destroying fungi are able to send their threads right through the wood fibers, breaking down the cell walls and utilizing portions of this decomposed material as food. This action very markedly weakens the wood, making it crumbly, stringy, or spongy; in other words, producing rot or decay. The presence of wood-destroying fungi in an advanced stage of growth is evidenced by fruiting bodies, commonly called mushrooms, toadstools, conchs, or brackets.

The principal economic loss caused by molds is through the staining or discoloration of the wood. No greater injury may be caused by the wood destroyers in their early stages; but their work will continue and finally result in the destruction of the wood if favorable moisture and temperature conditions prevail. Further details may be had from the Forest Products Laboratory, Madison, Wis.

Flying Yet Not Flying

YEAR after year new amusement devices are added to our amusement parks in order to furnish new forms of entertainment to a fickle and even jaded public. Now comes a Californian, R. R. Reed, who has hit upon the novel idea of supplying the thrills of flying without any of its dangers. He achieves his end by making use of a simple motorless monoplane which is shown in the accompanying illustrations, a system of cables and pulleys, and an electrically driven drum. The drum, it will be noted by studying the accompanying illustrations, supplies the motive power to the airplane, which rises off the ground in the same manner as a kite being pulled by a running boy. However, in order to maintain the lateral balance of the airplane, a system of cables is placed over the course of the flight to guide the pilotless machine. Upon completing its short trip the airplane, which is provided with wheeled landing-gear at front and rear, is hauled back to the starting point, and is at once ready for another "flight."



The pilotless airplane in flight and, at the other end of the cable, the electrically-driven drum which supplies the motive power

The Mechanism of the Pipe Organ

What Happens When the Player Passes His Fingers Over the Keys

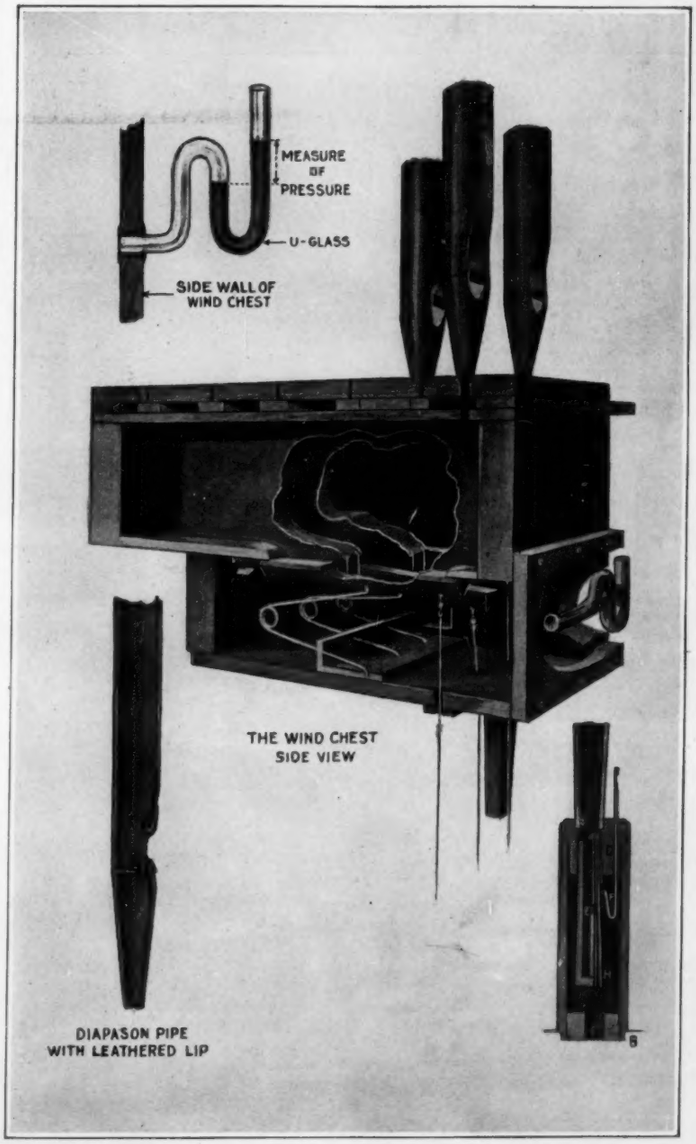
By J. F. Springer

WHILE people in general are familiar with the appearance of the keyboards, stops and exterior pipes of the pipe organ, few have anything but a very vague idea of the means by which the pressure of the finger on a key operates to send a jet of compressed air into one or more speaking pipes. The combination of mechanical and other elements leading to this end is the *action*. Pipe organs are controlled by different styles of action. But all have *wind-chests*. These are boxes, filled with compressed air, and placed beneath the bottom openings of the group of pipes served. Each of the openings into the individual pipes above is closed by means of a kind of hinged valve called a *pallet*, and into groups of pipes by sliding valves called *sliders*. To cause a pipe to speak, it is only necessary to open the proper slider and the proper pallet. Ordinarily there are as many wind-chests as there are subsidiary organs in the instrument. Thus, the great organ or the swell organ will consist of an aggregate of pipes served by its own special wind-chest. There are some big organs in England, and perhaps others elsewhere, which provide more than one wind-chest for a single subsidiary organ. In the Town Hall at Leeds, England, the pipes of the great organ are divided into two aggregates, each of which has its special wind-chest.

The several subsidiary organs are subdivided into groups of pipes called *stops*. Each stop ordinarily consists of a series of pipes belonging to a continuous portion of the chromatic succession of musical notes and all having some especial tonal quality in common. Thus, a flute stop will consist of a series of organ pipes corresponding to all the notes in some range of pitch and all having a flute-like tone. To play a subsidiary organ, one first draws the desired stop-knobs or stop-handles, which in consequence draw the sliders of the corresponding stops. No sound issues as yet, because the pallets still block the way of the compressed air. The keys of the proper manual or pedal board are now depressed severally or in chordal groups with the result that the corresponding pallets are opened and the compressed air allowed to rush into the corresponding pipes. The organ now speaks in single notes or in chords.

A little thought will prepare one to understand that it is quite important how and when the pallets respond when the keys are depressed. It is highly desirable that nothing akin to a "hang fire" response occur. In modern organs, the console is often at a very considerable distance from many of the pipes. The keys may, accordingly, be near some and distant from others. There should be no difference in the response of the corresponding pallets. It would be intolerable to strike chords on two manual boards and one pedal board simultaneously, only to hear from the three different organs at three different instants. It will perhaps be gathered from these remarks that the action is a vital feature, because it is the very thing depended upon to connect the movements of key and pallet.

A representative wind-chest is shown in side section in the group of drawings on this page, and again, at the lower right, in front section. The box A is the wind-chest. The compressed-air supply may be introduced through the side or bottom. In the present case, it is supplied through the windtrunk B entering at one side. The sliding piece F is the slider for one stop. It must first be drawn to admit air to these pipes. Admission is further controlled by the pallets C. Springs beneath these pallets hold them up against the exits from the wind-chest. Several of these springs are plainly in view in the side view, holding their pallets in closed position. Wires, known as *pull-downs*, are attached to individual pallets and are passed vertically down through small holes in the bottom of the wind-chest. Upon one of these wires being pulled down, the pallet will be opened and the compressed air allowed to rush in through D to the foot of the organ tube above. The mode of attachment of the pull-downs to the pallets is by means of loops of wire secured on the under sides of these valves. The sliders are long strips of wood pierced at intervals with holes. When the stop-knob is pulled out, the slider shifts so as to bring these holes underneath the individual pipes of the stop; and when the stop knob is pushed back, the unperforated spaces between holes close the air conduits. Naturally, there is no great difficulty in providing the necessary mechanism for shifting the sliders back and forth, except perhaps where the distance between stop and stop-knob is considerable. But the case of the pallet is far different. In the older system, the connection between key and pallet was made by means of a series of links and levers. The series was called the *tracker action*. The pallet eye and the pull-down were at one end of this.



Center: A typical wind-chest, seen in side view. *Lower right:* The same wind-chest seen from in front. *Upper left:* The double-U tube for registering the compressed-air pressure in the wind-chest. *Lower left:* Open diapason pipe, showing the leathered lip

Drawings of modern organ parts, showing where the wind comes from and where it goes

In one of the views is shown a model exhibiting in section the entire mechanism, including the rocker action, from manual key to speaking pipe. Two white keys are in view, the one in front being depressed. As it is down, so also should the pallet be down. This may be seen to be the case by looking further to the right and further up. A transverse section of the wind-chest is seen, together with the depressed pallet and the spring underneath it. Two sliders may be seen, in section. Apparently, the wind conduit near the one is cut off by one slider; that near the other is open, the hole through the slider being in line with the parts of the air conduit above and below. Consequently, with this conduit open all the way at the same time that the pallet is depressed, compressed air from the wind-chest will rush in above the pallet and up through the open conduit into the foot of the pipe immediately above. The key being down, the vertical arm at its right-hand end is up. Consequently, the right-angled lever on the left has been slightly shifted clockwise on its pivot. There is, to the right, a second right-angled lever. The lower arms of both levers are connected by a horizontal rod or link. The effect of the clockwise shift of the left-hand lever was to shift clockwise the right-hand lever. The upper arm of the second lever was consequently depressed and a drawing-down of the links above effected. That is, the depression of the key produced a downward pull on the pull-down and a depression of the pallet.

Ordinarily, there are about six joints in a rocker section and these were naturally sources of friction. In order to restore conditions when the finger of the player was lifted, the spring under the pallet had to be strong enough to overcome quite a number of weights and sources of friction. Indeed, there would frequently be another complication, involving additional friction. This was a device known as the *roller board*. Its function was to transmit sideways the pull designed to depress the pallet. This needs explanation. Frequently, keys close together control speaking pipes of considerable size. If heavy pipes were all to be put in the same vertical plane with the key, then for the case where a series of keys controlled a lot of big pipes of the same stop or subsidiary organ, the wind-chest might be excessively weighted at one end. As this was undesirable, the roller board was introduced in order to provide for a better distribution of the weight along the length of the wind-chest. Further, big organ pipes consume an immense amount of air. To provide adequately for its introduction to the foot of the pipe, the corresponding pallet was given a larger area. It will now be understood, perhaps, that with this greater size of pallet conjoined with the action of the roller board, the spring underneath the pallet had to be a good strong fellow in order to restore normal conditions of the whole action. This spring, however, had to be overcome by the organist in order to produce the sound. We have here an explanation of the difficulty of playing many lower notes on older organs. In fact, the old system involved still other sources of difficulty, particularly the resistance of the wind pressure which was added to as the number of stops in use was increased. When the organ was a large one with many stops, and the keyboards were coupled together, it required considerable exertion to bring out the full power of the instrument; sometimes the organist had to stand on the pedals and throw the weight of his body on the keys to get a big chord. Various schemes were tried to better matters. The most successful appears to have been a division of the pallet into two parts. A reduced quantity of wind was introduced and this relieved the pressure underneath

before the pallet was completely depressed. But the results now possible with modern organs were out of the question.

An improvement was made in England. It consisted principally of a little bellows about nine inches long, which was given a duty in connection with the action. The organ wind itself would be admitted to this bellows by the effort of the player against a small valve. The wind rushing in and expanding the bellows, the mechanical movement of the top of the bellows was utilized to depress the pallet. C. S. Barker, the inventor, proved to be a prophet without honor in his own country, and went away to France where the practicability of the new idea was established. After this, his own people woke up and the *pneumatic lever* became in time a thoroughly recognized feature in successful organ building. Modern organs of the most up-to-date character are understood to use actions whose development was founded upon this invention, which dates back from about 1832.

In the old days, before Barker and his progressive contemporaries and successors had met with full success in introducing their ideas, an ordinary key, when coupled, required a pressure of 20 ounces to depress it. It was not uncommon to find bass keys requiring a pressure of 50 ounces or more. There is in New York City an organ having bass keys requiring a pressure of 40 ounces. But the modern organ is built so that a pressure of 3 to 4 ounces is the standard effort required. The pneumatic action, as developed by Willis, Cavillé-Coll and many others, is for short distances between key and pipe, a fine device and is said by competent authority to be prompt both in attack and in repetition.

Apparently, the first installation of the *tubular pneumatic* action was made in the construction of the big English organ in St. Paul's Cathedral, London. The organ was divided into two parts and the keyboards located in the one half. Under the old system, this would have required running trackers down to and underneath the floor (30 feet below) and up again. The builder, however, used tubes instead and thus arranged that an impulse of air should pass through and accomplish the desired result with the aid of pneumatic levers. This action has been praised and condemned. It is much in use, in a modern form, and is doubtless successful under favorable circumstances. A long distance from key to pipe is apt to prove a large difficulty in the way of its satisfactory use. Pneumatic impulses travel slowly—at a speed which does not reach 1100 feet per second. And yet it became desirable to locate the organ at points far from the player. As late as 1890, in response to a desire for such arrangements as would permit the organist to be very close to the cathedral choir, a big English concern stated that "Dame Nature stood in the way."

Today, however, organs are built and distributed all over. The console is even movable from point to point. The instantaneous action and incredible velocity of the electric current make it an ideal agent for the transmission of the impulse of the organist's fingers to widely scattered pipes. The first attempts seem to have been, for the most part, failures; but the fundamental idea was so attractive that builders and inventors persevered. The original invention has been ascribed to Barker, already mentioned, and to Dr. Péschard. The early experiences resulted in a poor reputation for electric actions. The revival of interest later on was, it seems, to be ascribed to Mr. Robert Hope-Jones. He was a skilled electrician, but was unacquainted with the efforts that had already been made. He constructed the first movable console. This was apparently about 1886. He created an electric action that roused the organ world.

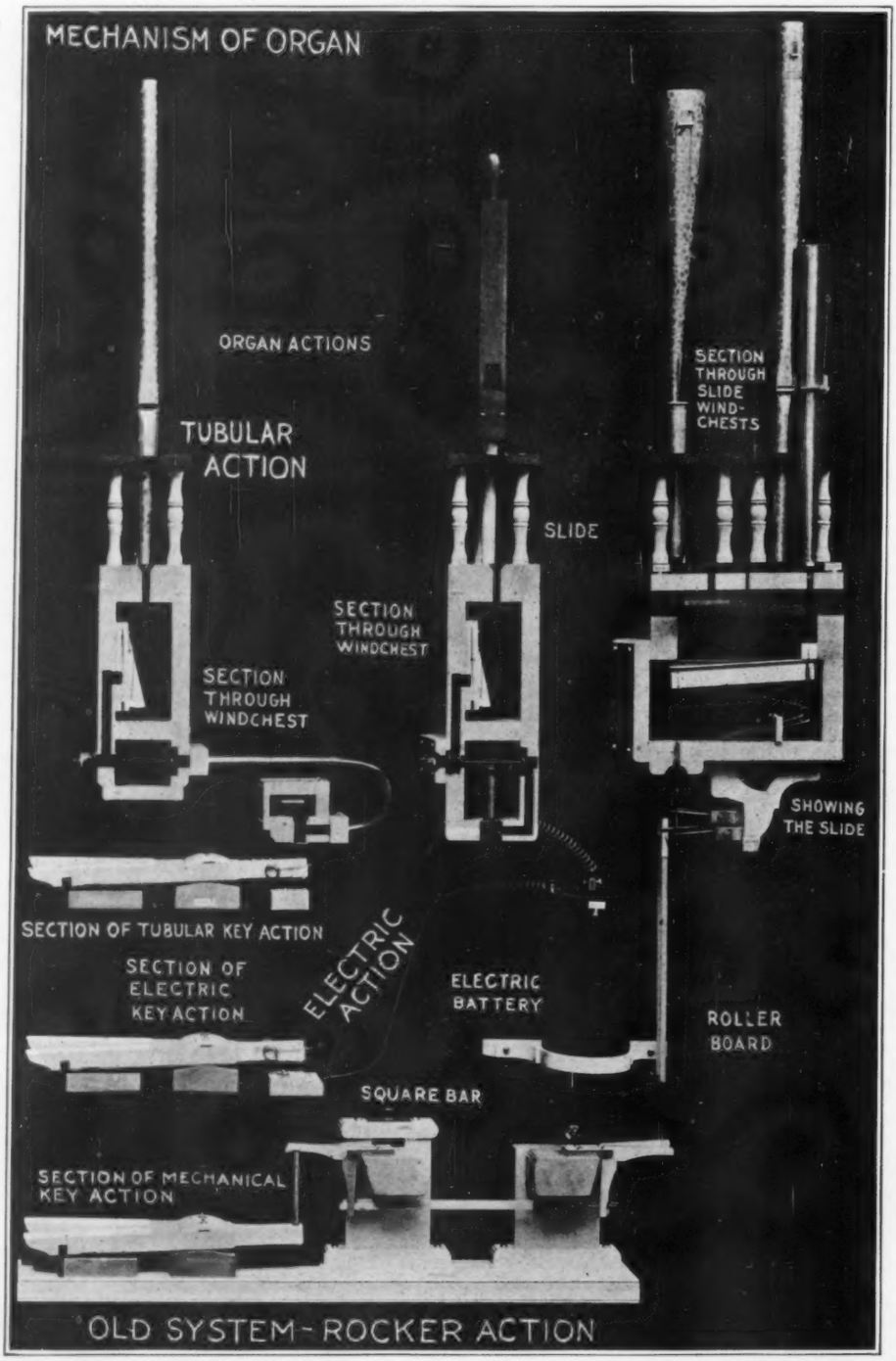
Naturally, the matter has been developed during the past years. In one of the views of sectional models is shown an electro-pneumatic action. The organ tube is at the top. The wind-chest is below. The pallet which admits and shuts off air is seen at top of the interior of the wind-chest. Beneath the latter is the magnet box. Through these, the electric current which is caused to flow by depressing the key operates one or more valves controlling the air supply. A small bellows-motor is seen in the wind-chest, whose duty it is to move the pallet.

The perfected tubular pneumatic and pneumatic-electric organs are often divided into parts. In this way, organs have been successfully installed in buildings which could not have received a big organ *en bloc*.

An important feature in many modern organs is the *stop-key*. This is a substitute for the stop-knob or stop-handle. Some organs have stop-keys only; others have them as part of the equipment for the control of stops and couplers. The stop-key may assume the form of an ivory tablet. It is only necessary for the organist to touch it to get the service desired. With a row of them, the finger simply passed along suffices to put great masses of pipes into and out of action.

A second great advance in organ development has to do with the modifications of tone that may be brought about by suitable means. Tone has to do with the quality of sound and is concerned not at all with its fundamental pitch. It is a discovery of the nineteenth century that the difference in quality of musical notes from different instruments is due to the number, relative strength and distribution of certain subsidiary sounds sometimes termed overtones. If there are no overtones, the sound is pure. Perhaps the best example is the note produced by the tuning fork. Most musical sounds are, however, composite—that is, they consist first of a dominating pure sound whose pitch is reckoned as the pitch of the whole; and, second, of an assortment of weaker sounds of higher pitch. If these overtones are very well confined to pure tones having such pitches as to produce a proper musical chord, then the total effect is pleasing and we say that it is a musical sound. But, if there are overtones such that the total combination contains prominent pure tones falling outside of a proper chord, we have a noise. There is doubtless a borderland where the harsh effect is mild and subdued and is not unpleasing to the ear.

If the sounds issuing from a pipe organ were confined to pure tones, the general effect would be quite insipid. The simplicity would be excessive, and a tendency would undoubtedly come into existence to play the music in the regions of high pitch, in order to get rid of the intolerable dullness that would otherwise attend the rendition. That musical sounds are, for the most part, really composite admits of a ready illustration. Let the reader go to a piano, depress the loud pedal and strike sharply the C which is two octaves below middle C. Perhaps at first he may distinguish nothing else than the C, however attentively he listens with the idea of noting something else. By persistence, however, the



The rocker action, formerly the standard, compared with the tubular action and with the latest style of electrical action

How the operation of the keys is communicated to wind-chest and pipes

time will probably come rather soon when he will hear not only C but also G. Other notes may be detected by continuing the experiment. Technically, the fundamental pure tone of a musical note and the weaker pure tones of higher pitch are termed the *partial tones.*

Now it was found out long ago that, while the effective length of a tube is a principal factor determining the fundamental tone of the note uttered by it, this was not the only factor. Thus, with the tube used in orchestras and known as the French horn, various fundamental tones may be produced by tightening the lips and increasing the pressure on the air jet issuing from the mouth. Thus, C two octaves below middle C, C one octave below, middle C itself, and C one octave higher, may all be produced without changing the tube length—as by finger holes or valves. In fact, the G just below middle C and also the first and second octaves above this G may be got without introducing any change of length. Next, we may get E above middle C and its octave above. Finally, we may also get D, F and A of the octave above that beginning with middle C. Upon realizing the foregoing, one is prepared to understand that wind pressure plays its part, and that higher notes may be developed by increasing it.

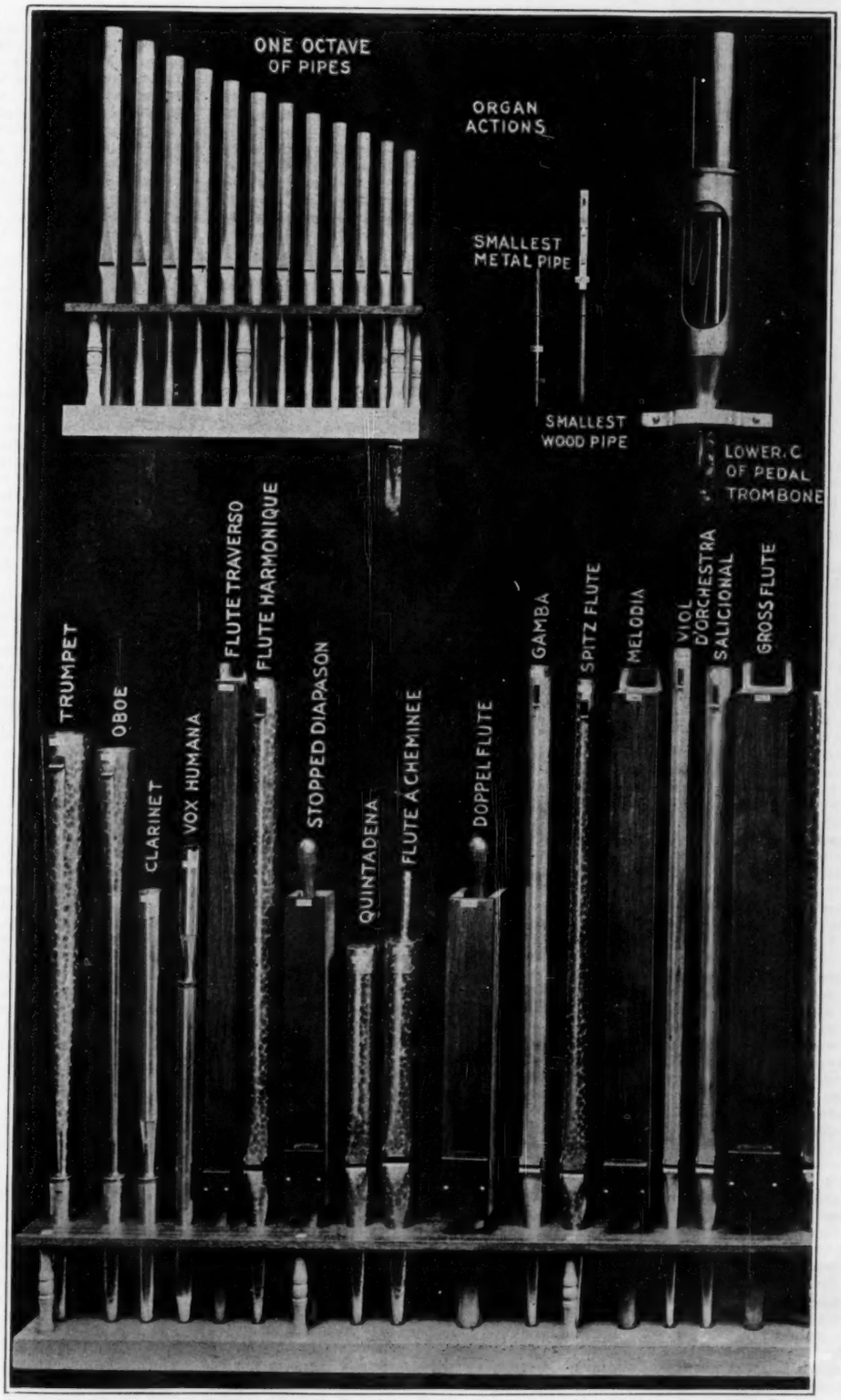
The old organs seem to have been voiced upon very moderate wind pressures—say, from ⅞ ounce to 1¾ ounces per square inch. The pressures are usually stated in terms of the inches of height required by a head of water to produce an equal pressure. From this point of view, it may be said that the old organs were generally voiced in the range 1½ to 3 inches. This custom arose, apparently, from the use of the wind-gage invented about 1677 by Christian Förmer. It consists of a glass tube having a double-U shape. A little water is put into the tube and then one end is inserted, along with a socket, into a hole in the wind-chest. The air pressure may, if the tube is covered properly, be made to hold the water in the more distant U so that it will disclose different levels in the two vertical arms: see the first group of drawings. The difference in level is manifestly the head of water restraining, and therefore equal in pressure to, the compressed air. Modern organ pipes are voiced at pressures running up to 10, 20 and 30 inches. In large organs, there may be different pressures for different wind-chests. As the pitch of the fundamental—or first partial, as it is called—may be varied by changes of wind pressure, it is not so difficult to grant that quality may be modified by variations in pressure. The modern advances in respect to tone building depend in part upon the increased pressures now in vogue.

The quality is affected also by the *material* and by the *shape* of the tube. There are still several other factors which contribute to this.

Even in the older days, the material and shape were understood to influence quality. And it was also understood that an open pipe gave a different quality of tone than a stopped one. The difference with us, as respects this last point, is that we have some comprehension of why this is the case. We now know that the upper partials are different. Thus, the pitches of the series of partials, beginning with the first, for an open pipe may be represented by the series of numbers 1, 2, 3, 4, etc.; while those for a closed pipe, by the series of numbers 1, 3, 5, 7, etc. That is, these numbers show the relative numbers of vibrations. With the open pipe, we get the successive octaves of the fundamental, which naturally tend to strengthen that sound. One should bear in mind, in this connection, that the octave next above is always got by multiplying by 2. If one writes out the two series at some length, he will have opportunity to see that the first consists of the second plus octaves of the second. But these octave echoes of the second are doubtless, in general, rather faint; so that a better comparison is simply to view the first few partials of each as substantially the whole. Thus, if we regard 1, 2, 3, 4, as all that correspond to the open pipe, and 1, 3, 5, 7, as all that correspond to the closed pipe, we are ready to see that the open pipe gives a simpler sound, since 3 is the only number not an octave of the fundamental. With the numbers of the closed pipe, we have four different numbers, no one of which is an octave reproduction of the other. The open pipe, thus analysed, is perceived to utter a purer and simpler tone. The closed pipe by adding marked differences gives forth a more brilliant sound.

There is a method of getting a kind of subsidiary partial. If two musical tones of different pitch are sounded together loudly and continuously, secondary tones will be heard. In particular, if two organ pipes having an interval of a fifth, one of them CCC (3 octaves below middle C) and the other GG (between CC and CCC), are sounded together, there will be sounded a note that is an octave below the lower one. This is CCCC. Thus, by using a pipe 16 feet long in conjunction with another 10 2-3 feet long, an effect is got that ordinarily requires a similar pipe of 32 feet in length. In this way is got the series of notes indicated by the label on the stop-knob as *32-feet resultant.* Another method of getting a low tone by similar means is to sound simultaneously two pipes a major third apart. Two octaves below the lower one of the two will sound. This may, perhaps, never have been utilized as a means of providing a special series of notes by simply drawing a stop-knob; but the organist himself is privileged to make use of it. He may thus produce lower sounds than the organ is supposed to be capable of, by playing two pedal notes simultaneously.

The *open diapason* stop of the great organ is the series of pipes in an organ which may be regarded as the foundation of the whole musical capacity of the entire instrument. These are ordinarily simple open pipes of wood with a suitable foot. About 1862, an advance made by a builder named Schulze was brought into prominence. He gave the mouths of the pipes a much greater width and provided for a freer blowing. The result was an increase in



Below: A miscellaneous collection of typical stops from various sources. *Upper left:* A full octave of pipes from a single organ. *Upper right:* Further details of characteristic stops

Typical stops of various sorts from modern organs

power and also in brilliance. Apparently, however, this treatment yielded a hardness of tone and lost the singing quality of the older open diapasons. About a quarter of a century later, Hope-Jones narrowed the mouth, inverted the languid, and thickened the metal wall. The lips were covered with leather. It is claimed that this method enables strong pressures (up to 30 inches) to be used, without the unwanted hardness of tone. The general result is understood to be substantially the old open diapason but with greater power. The leather lip, as applied to organ pipes, has become very popular indeed, both in England and America. One of our drawings shows a Hope-Jones open diapason pipe with its inverted languid, leather lip and clothed flue.

Mixture stops are apparently becoming obsolete. A number of ranks of pipes were combined with the idea of adding upper partials to old diapasons poor in overtones. The mixture stops have become unpopular probably not so much because the theory was wrong in general principle, but because the upper partials are comparatively too powerful.

The *Flute* stop is an important part of any organ. The modern development of these pipes is largely centered upon stops having the family name of *Tibia*. One form of this style of pipe is made of wood and on a large scale. The mouth is placed on the narrow side of the pipe. The block is lowered somewhat and the thick lip is covered with a thin strip of leather. The wind pressure may be anything from 4 inches up. There are whole groups of modern stops known as varieties of tibia. Thus, there are the *tibia mollis, tibia minor, tibia dura*, etc.

Among these modern stops which belong to the general advance are certain ones which imitate stringed instruments. William Thyme is the great modern pioneer. In 1886, his string stops were brought to public attention by the Exhibition held that year in Liverpool. He has been followed by Hope-Jones and other progressive designers of organs.

The use of the reed in a pipe is a very ancient matter, dating back at least to the times of the old Egyptians. The shepherds pipe found in the Tyrol today consists of a tube with a reed or strip of cane in the mouthpiece. The clarinet, however, is to be regarded as the immediate parent of the reed pipe used in the modern organ. There have been reed pipes in organs for many years, but it was not until 50 or 60 years ago that the great English organ builder, Henry Willis, began to develop them. That the tone quality of the old pipe was poor is thought to be witnessed to by the old instruction books for students of the pipe organ. These books stated that the reed pipes should never be brought into use by themselves; but that a stopped diapason or other group of fine pipes should be employed along with the reeds. Willis changed all this. His reeds were, some of them at least, characterized by beauty of tone. Fine simple pipes of the open or stopped varieties were not needed in conjunction. Even in the matter of power, he raised the wind pressure and got it from the reed pipes alone. Willis seems to have been the first to prove that roughness and rattling could be entirely removed simply by giving the reed tongue precisely the right curve. He prevented some of the big reed tongues from making vibrations in too emphatic a manner by securing to them weights of brass.

The use of double-length tubes for treble notes made possible great brilliancy and power.

Hope-Jones distinguished himself in the department of reed pipes, as elsewhere; but he does not seem to have been a pioneer. He added to the results attained by Willis and others. Thus, he has improved the Willis chorus reed pipes by doubling the pressure, adding to the loading, and thickening the tongue. His double English horn and oboe horn are examples of stops of perfected beauty and power.

The Oil and Albumen Content of Seeds

A Study of the Conditions Under Which the Seeds of Oil-Bearing and Textile-Producing Plants Give Their Highest Yields

THE importance of obtaining the greatest yield of oil and fat as well as textile fiber and albuminous matter from the various oil and textile plants is evident, and during the war the necessity for maximum yield was accentuated very strongly in Germany. For this reason a very detailed study of the conditions under which the plants gave the maximum yields was undertaken. The results of the experiments are described by Dr. Kleberger in an address of which this article gives an abstract.

The plants studied were the rapeseed plant, the poppy plant, the flax plant, the hemp plant, and the dodder or oil seed plant. The literature was investigated and was found to be very scanty on the subject. Investigations were made by some experimenters on the conditions of the formation of oil and fat in the seeds of various oil-bearing plants, but nothing was done in a constructive way to determine when the formation of the oil and fat was at a maximum.

In the present investigations the seeds were tested in three stages of development, as follows:

1. In the state of green ripeness, that is, in the condition where the green seed was completely developed without there being any visible signs of the ripening of the seed having started.

2. In the state of yellow ripeness, that is, in the condition where the seed shows its full growth and manifests visible signs of the beginning of the ripening process. (The color is not necessarily yellow, it may be light brown.)

3. In the state of full ripeness, that is, in the condition where the entire plant has reached a stage of complete cessation of growth and where the seeds show their normal ripe color.

In all the seeds that were investigated, it was found that the total content of the seed in nitrogenous substances was at a maximum always in the stage of green ripeness. Similarly, the content in amides and albuminous-like substances was a maximum under this condition. In the same state of green ripeness, the content of the seed in true albumens was at a minimum.

The true albumens vary between about 15 to about 20 per cent of the total nitrogenous substances in the seed at this stage of ripeness. When the seed reached the condition of yellow ripeness, then the amides had decreased considerably, and likewise the content in total nitrogen had been reduced to a considerable extent. On the other hand, the true albumens showed a decided increase, but this increase was nevertheless smaller than the decrease in the amide content. This is why it appears that the nitrogen content, that is the content of the seed in gross protein matter, is considerably reduced when the seed reaches the state of yellow ripeness. One exception to the rule must be mentioned at this point, namely, in the case of the hemp plant. In this plant it was found that at the condition of yellow ripeness the amide content of the seed had been reduced very considerably in contrast with the true albumens, so that about 45 per cent of the albuminous materials in the seed were present as true albumens.

When the plant has ripened completely, then the situation changes radically. Due to the fact that the need has gained very materially in non-nitrogenous substances, the percentage of the nitrogenous constituents has decreased very greatly, and the amides have been reduced likewise to a still greater degree. On the other hand, the true albumens have increased very greatly, so that at this point they amount to more than 50 per cent of the total nitrogenous substances present in the seed. Here again in the case of the hemp plant, a notable exception is to be mentioned in that there is scarcely any increase in true albumen content to be noted at the stage of complete ripeness, compared with the proportion in the seed at the stage of yellow ripeness.

In all the seeds in the green ripe condition the amount of fatty substances present was extremely small. The seed in that condition appears to be made up of layers of waxy and resinous substances which cover the seed coat and protect it from external influences. The percentage of true fats of the total fatty matter in the seed is also very small. An important change takes place by the time the seed has reached the state of yellow ripeness. The increase in the total fat content has been so large that in the case of the poppy seed, flax plant, and dodder seed this percentage of fat is almost two-thirds of what it is in the condition of complete ripeness of the plant. However, the quantity of resins and waxes is still comparatively large and it still has a very considerable influence on the quantity of true fats present in the seed.

It is only when the seed has reached the stage of full ripeness that in reality we obtain a true idea of what the oil seed contains. Now the resins and waxes have been reduced considerably and the fatty substances in the seed amount to about 30 to 45 per cent of the total dry weight of the same.

We again have an exception to the rule in the case of the hemp plant. Here it appears as if the greatest part of the true fatty content of the seed had been developed at the time the seed was yellow ripe, and the increase in the total fat content as well as the increase in the proportion of true fats is only very slight from the yellow ripe stage to the condition of full ripeness. The following conclusions are drawn:

1. The maximum content of nitrogenous substances in the seed occurs in the green ripe stage. It is decreased in the yellow ripe and full ripe state.

2. In the yellow ripe condition, the nitrogen content is constituted overwhelmingly of non-albuminous materials, amides, etc.; in the full ripe stage true albumens predominate.

3. The fatty content in the seeds which were examined in this investigation, in the green ripe condition was very slight, the far greater part of the non-nitrogenous substances being made up of non-fats, resinous and waxy compounds. When the plant has reached the condition of yellow ripeness, then the content in fatty substances has been increased materially, and particularly the proportion of true fats has grown considerably. In the state of complete ripeness it has reached its greatest development, and the proportion of resins and waxes in the seed has been correspondingly reduced to a minimum.

An explanation of these phenomena is found with ease in the science of plant physiology. This science teaches us that when the plant is young there is found in it a preponderance of substances which are of nutritious value and which are required by the plant to build up new cells and grow. These substances are then present in their maximum degree and contain largely nitrogen in their composition. As the plant grows older, that is, as it ripens, these nitrogenous substances are no longer required by the plant for its growth and are then stored up as true albumens in the seeds.

In the same manner the science of plant physiology teaches us that the fatty substances in the plant are stored in the seed in the maximum degree when the plant has reached its maturity. The explanation of the one exception in the case of the hemp plant cannot be given at this time, but requires further study.

A question of very great industrial and agricultural importance is what happens to the albumen and fat content of the seeds when they are reaped in various stages of ripeness and then stored in the granary. To answer this question we reaped the seeds in various degrees of ripeness and stored them in the granary for eight weeks until they were thoroughly dry.

It was found that the seeds reaped in the green condition shrunk very considerably, so that their outer surface was completely shriveled. Their total nitrogen content was almost the same as that of the seeds in the yellow ripe condition, but the proportion of true albumen was much less than in the seeds that were reaped in the stage of yellow ripeness. There was less shrinkage in the latter seeds and their nitrogen content was just about normal; nevertheless, the percentage of true albumens present was considerably less than that in the seeds that were reaped in the condition of full ripeness.

In the latter sort of seeds no change appeared to take place except a considerable loss of water. As far as the content of fatty substances is concerned, the seeds reaped in the green stage, after they had been stored for two months, still contained an extremely small percentage of fats and oils, there having been almost no increase in the fat content at all during the period of storage. On the other hand, in the case of the seeds which were harvested in the yellow ripe condition, the storage appeared to effect an increase in the fat content of the same. This increase was rather appreciable. The proportion of true fats was much greater, but the total fats in the seeds were still less than that in the seeds which were reaped when they were absolutely ripe. In the case of these seeds, storage did not have any effect whatever on the fat content.

In the case of the hemp seeds the above phenomena appeared to be accentuated the least, while in the case of the flax seed they were accentuated the most. The German technologists and agriculturists have decided from the results, which we have described above, that all oil seeds are much more valuable, yield a greater amount of more valuable oil and give oil-cakes which are richer in albumens, the more nearly ripe the seeds are when they are harvested.

Engineering in Truck Tire Building

Designs Which Decrease Wear, Prevent Slipping and Increase the Economy of Truck Operation

By H. W. Slauson, M.E.

TIRES are more than mere bands or tubes of rubber surrounding the wheels of a motor vehicle. Real engineering design, manufacturing science and chemical laboratory work must enter into their production in order to meet the severe requirements of present day trucking. Truck tires must not only sustain the weight of an overloaded vehicle but must absorb the jolts and jars of rough road travel, must retain a firm grip on wet, slippery or soft highways and, in the case of the rear wheels, must transmit the entire power developed by the engine (exclusive of the slight frictional losses in transmission, bearings and the like) whether it be ten or fifty horse power.

To meet these severe conditions of transportation, tire manufacturers have designed three principal types of truck tires. The newest is the pneumatic tire which has developed from the type used on passenger cars. The advantage of the cord fabric used in the construction of cord passenger car tires has made possible the design of practical pneumatic truck tires up to seven and eight inches in cross-sectional diameter and has resulted in the experimental use of sizes as large as ten and twelve inches.

The carcass of these tires is practically the same as those used on the larger passenger cars, except that, as the diameter is increased, additional plies of cord fabric are used to enable the tire to withstand the high pressures to which the casing is subjected when a heavily-loaded truck strikes an obstruction in the road. The eight-inch pneumatic tire, which is the normal size for a 2½ to 3-ton truck, should carry 110 pounds per square inch of normal inflation pressure and this will represent the normal strain to which all parts of the carcass are subjected when the truck is stationary and whether it be loaded or empty. When travelling, however, the hammer blows struck by the rear wheels as the vehicle passes over depressions or obstructions in the road increases this pressure greatly until it may reach four or five times its normal amount momentarily. The compressibility and elasticity of air enables the tire to absorb such jars without great danger of sudden blow-out. Therefore, it is a matter of wonder, not that the pneumatic tire when used in severe truck service does not give greater mileage, but that it can average from five to seven thousand miles each, with the necessity for a removal but once during that period for repair or replacement.

If we consider the larger sizes of truck pneumatics—those which must carry inflation pressures of 140 pounds per square inch—we find an interesting situation. Regardless of the load on the tire, the pressure for each square inch of surface of road contact will be 140 pounds,—a pressure which may well serve to rut soft asphalt surfaces. The pulling power of the pneumatic in snow or mud is great, due to the rounded contour of the tread which brings additional surface of the side wall into play as the tire sinks deeper in the mud. Nevertheless the average pressure of the tire will be 140 pounds per square inch. This will prevail whether the truck be loaded or empty, as already stated. As load is added, the pressure, fortunately, does not increase above this maximum, but the tire is flattened so that a larger surface (each square inch of it carrying 140 pounds of pressure) is presented to the road. This is a feature of pneumatic truck tire operation overlooked by many county authorities and highway commissioners in their short-sighted attempts to limit truck loads to an inefficient and absurd maximum. Such highway engineers would not be tempted to permit the use of pneumatic-tired trucks in preference to those of solid or cushion tire if they realized that the pressure per square inch of road contact of the pneumatic tired truck is the same, regardless of the load carried, and is based entirely on the necessary inflation pressure. If this inflation pressure is reduced below the recommended amount, the tire will become unduly flattened, which will cause bending of the side walls and a rapid separation of the various layers of fabric and rubber of which the carcass is composed. Nothing injures a tire more seriously than its operation when insufficiently inflated.

One of the principal objections to the use of the pneumatic tire on moderate-sized trucks is the cost. It may enable perishable loads to be carried at fairly high speeds, but the cost per mile for the two rear tires alone of a three-ton truck is nearly $.02½ based on the not-usually-obtained distance of 10,000 miles and making no allowance for the cost of repairs for blow-outs, punctures or retreading.

The solid tire is a tire which has been used almost exclusively on trucks up to a few years ago. It is reliable in that its mileage can be predicted with comparative accuracy. It is a considerably cheaper tire than the pneumatic and the mileage which it delivers is somewhat more. Excessive wear does occur in the solid tire, however, and the cause represents one of the most serious features of tire construction with which the designer has to contend.

Rubber cannot be compressed but it is sufficiently elastic so that it may be made to flow or be replaced. When we pump air into a pneumatic tire, we compress that air because we force a larger amount into the same restricted space. This cannot be done with rubber. If we place a pencil with a soft eraser upright on the desk and push downward on the rubber end, the eraser will be made to bulge out on the side. The rubber is not compressed but it is replaced. What it has lost in length has been compensated for by its increase in width, represented by this bulge.

When a rubber tire is subjected to load on the truck it becomes flattened at its point of contact with the road. The rubber thus displaced must go somewhere and it "oozes out" in the form of a bulge at the front and rear of the flat portion. This bulge follows in front of the tire as it rolls along the pavement and forms what is known as the "traction wave." As the traction wave rolls round it continually stretches various sections of the tire, for there is no place into which the bulge may flow. Thus, smooth solid tires will be worn down even though the truck be operated only over hard, well-paved streets.

The fact that the rubber of the solid tire has no place to which it may flow when subjected to pressure greatly reduces the resiliency of this tire and makes it hard riding and unable to absorb the inequalities in a road surface, with the result that the truck is badly racked and damaged through the undue vibration communicated to it.

Thus the principal advantages of the solid tire are its longer life than the pneumatic, its reliability so far as freedom from blow-outs or punctures is concerned, and its low initial cost.

In order to overcome the objections to the solid tire and to provide something with a certainty of mileage, reliability, longer life, low initial cost and ability to secure traction, engineers have designed the cushion or semi-solid type of tire. This type of tire depends for its action on the theory which we have already stated—that rubber is not compressible, it is merely replaceable. As we have seen that the traction wave represents the greatest element of destruction in the operation of a solid tire it will be realized that the use of properly-placed displacement notches may serve to overcome this difficulty. In the case of several typical tires of this make, these notches are placed on each side and extend well in toward the center. They are not placed opposite each other, but are staggered, with the result that each section of rubber thus formed is bounded by a notch of ample width into which the rubber may "flow" when that section of the tire is subjected to contact with the pavement, under load. Through this localization of the strain the extensive and continued stretching of the rubber of the tire is eliminated and tires of this type deliver mileages greatly in excess of those secured from the simple solid tire.

Furthermore, such displacement notches or other recesses furnish positive grip to any kind of a road surface, which will enable the truck so equipped to negotiate snow, sand, mud or slippery pavements without the use of chains. Such tires give from 15,000 to 30,000 miles of service at an initial cost of one-half that required for a pneumatic of equal capacity.

The notches in such a semi-solid tire permit the displaced rubber to flow easily and freely. The resiliency of such a tire is much greater than that of a solid and even approaches that of a properly inflated pneumatic. The hammer blow struck by such a tire when it travels over an obstruction in the road is absorbed by the live, elastic rubber which, instead of being forced out into the form of a bulge on each side, is merely moved or displaced into the adjoining notches which are placed at exactly the correct intervals through the circumference of the tire, on each side.

Even the tread of the pneumatic tire may be subjected to the destructive traction wave. The tread of a pneumatic tire is a comparatively thick layer of rubber placed over a carcass. While the interior of the tire itself is filled with air, the thickness of this rubber tread produces a flattening of the rubber itself. This rubber is no more compressible than is that of a solid tire and consequently the flattened tread must "flow" in some direction. If there is a smooth central strip on the pneumatic tire of a considerable area, the tread will be stretched and pulled as the traction wave travels. This causes tread separation, which can be avoided by the use of a non-skid surface composed of small cross-bars adjoining open spaces of a size sufficient to absorb the displaced rubber. Thus, pneumatic tire manufacturers have learned from the experience of solid tire manufacturers the best means for overcoming one of the most destructive elements attendant upon the operation of the modern tire.

Many other engineering and scientific considerations enter into the design of the modern truck tire. The use of a rubber compound giving exactly the proper resiliency together with the correct attention to wearing qualities is a matter of laboratory experiment. Each tire manufacturer may employ his own methods and he may evolve different chemical formulae. The truck owner of today, however, is given the best product of the tire maker's art and, except for the experimental stage in which the larger sizes of truck pneumatics are still to be placed, he may select his tire equipment with the assurance that he is obtaining his full money's worth.

EVERY truck user and everybody who sees trucks making their ponderous way through streets and over roads must have observed that, as Mr. Slauson says, there are three principal types of tires. We have the plain solid tire, the semi-solid type, and the pneumatic. The layman might hesitate to classify the solid tire and the notched one so boldly in different groups, but Mr. Slauson makes it clear that this should be done. And he makes clear, what might have been suspected, that there is no general answer to the question "What kind of tire shall we use on our trucks?" It all depends upon what we are going to do with our trucks: what sort of loads we are going to carry, and what sort of roads we are going to meet. But Mr. Slauson can tell it better than we can, so we leave it to him.—THE EDITOR.

Restoring Sight to Blind Animals

AT a general meeting of the Vienna Biological Society and the Ophthalmological Society of the same city, a young biologist named Th. Koppanyi, a student under the well-known biologist, Prof. Przibram, announced the results of his studies upon blinded animals.

His studies were based upon the experimental discovery that when either mice or fish have been blinded their coloring becomes dark instead of gaily ornamental as usual. But when he transplanted into the eye sockets of blinded fish and batrachians the eyes of similar animals, the former recovered their original bright coloring. This led him to conclude that the transplanted eyes had thrived in their new situation, so as to restore the sight of the animals operated upon. Pursuing his experiments with frogs and toads, he obtained further proof that the animals regain their sight. He then extended his researches to warm-blooded animals. He blinded a rat in both eyes and then transplanted into the eye-sockets of his animal the eye-balls of another rat. He soon obtained proof that both the retina and the optical nerve had resumed their proper functioning. Furthermore, microscopic examinations made by Prof. Kolmer, demonstrated the new eyes to be entirely normal and capable of functioning. It was found that the end of the transplanted optical nerve grew on to the amputated end of the nerve in the eye of the first animal. These conclusions afford hope that human beings may eventually be entirely relieved of the affliction of blindness.

The Banana and Its Uses

Getting Acquainted with This Tropical Fruit of Which There are Over Seventy Varieties

By William A. Murrill, Ph.D.
New York Botanical Garden

THE banana plant has been intimately associated with the primitive inhabitants of many parts of the tropics since prehistoric times. This is due to the ease with which it is cultivated and propagated, the luxuriance of its growth, and the abundance and food value of the fruit it bears. It was native to India and either grew naturally, or was a very early introduction, in other parts of tropical Asia, Africa, Australia, and the islands adjacent, preferring hot low regions where water and fertile soil were abundant.

The northern limit of its cultivation in the open is southern California and Louisiana, Florida, the Canary Islands, Egypt, and southern Japan and China. Few of the varieties will endure even a slight frost.

There is no definite evidence of its occurrence in American previous to the advent of the white man, the claim being made that the first banana plant was brought to Haiti from the Canaries by a Dominican in 1516.

A typical banana plant, although tree-like and somewhat resembling a palm, is in reality an immense herb, the false stem being made up of overlapping leaf-stalks. This so-called trunk may reach a height of twelve to twenty feet or more and a thickness of one foot; while the leaves are so large as to be used for umbrellas in some countries, being six to ten feet long and two feet across. The massive rootstock persists year after year underground, sending up new shoots as the old ones fruit and die away.

When old enough to flower, a true stem develops from the rootstock and grows up through the hollow center of the false stem, producing at its apex a single long flower-cluster, which is either pendulous or erect. This cluster is in the form of a spike, bearing large colored bracts which cover the inconspicuous, tubular, red or yellow flowers clustered at intervals on the main axis.

The first flowers to be seen near the base of the spike when the bracts fall away are female and give rise to the fruits, while the later flowers are male and bear the pollen. The large bud, or knob, at the tip of the cluster is simply a number of these leafy bracts which will never open. As the fruits increase in size, the axis elongates and gives them room to grow. A "bunch" of fruit is made up of several "hands," or layers, and each "hand" is composed of a number of individual fruits, or "fingers." When a bunch is cut, it is inverted and hung up by the "tail," or that portion of the floral axis which bears only sterile male flowers.

There are nearly seventy different species and over two hundred cultivated varieties of bananas in the world; but most of us are acquainted only with the yellow and red fruits seen in our markets and with a few species like *Musa zebrina*, *M. coccinea*, and *M. Cavendishii*, with colored foliage or attractive flowers, grown for ornament in our glasshouses. The species most cultivated for decorative purposes is probably *M. ensete*, a native of the mountains of Abyssinia. It is the largest species known and at the same time one of the oldest, being represented in the ancient Egyptian sculptures. The leaves are red along the midrib; the flowering spike is erect, with dark bracts and white flowers; and the fruit contains black, glossy seeds nearly an inch in diameter, from which the plant is easily grown.

In tropical countries, all parts of the banana plant are used. The leaves protect from the rain, serve as tablecloths, as wrappings for food during the process of cooking, and for various kinds of packing. When cut into strips and plaited, they make serviceable mats and bags. Cigarette papers are manufactured from the pulp of some species. All parts of the plant contain a watery juice which blackens on exposure to the air and forms an indelible stain. This juice, usually obtained by "bleeding" the young fruit-bunch, is used for marking cloth and decorating various household utensils.

Valuable fibers, suitable for the manufacture of ropes, clothing, etc., are obtained from the leaf-stalks of many species, especially the one known scientifically as *Musa textilis*, which supplies the abacá, or Manila hemp, of commerce. This species is a native of the Philippine Islands, where it is extensively cultivated. Unlike our ordinary banana, it bears seeds and the fruits are not edible. Plants are grown from seeds, root-cuttings, or suckers, and they mature in from two to five years, reaching a height of from six to fifteen feet. A plantation is cut over about every eight months, after which new plants grow up from suckers.

Left: Banana plantation in Cuba, with special reference to the long hanging stalks from the trees. *Right:* Young fruit and male flowers on a growing stalk in Costa Rica

The banana and how it grows

Immediately after cutting, the outer fibrous parts of the leaf-stalks are removed in long strips with bone knives and taken to the machines, where the fibers are pulled out between the edge of a long knife and a block of wood pressed against it by means of a pedal. This is very strenuous work, especially for a tropical climate, and if a man cleans twenty-five or thirty pounds of the fiber a day he is doing fairly well.

The outer layers of the leaf-stalk supply coarse, strong fibers used for ropes of various sizes, while the finer fibers used in the Philippines for hand-woven cloth come from the inner layers. Practically all of the abacá fiber exported is manufactured into rope and twine, its strength being nearly twice that of sisal fiber. The heavy cordage used on ships is made into Manila paper when too old and worn to be any longer serviceable.

The fruits of various species of bananas, and sometimes even the rootstocks, are very extensively used for food, taking the place of bread and potatoes in many parts of the tropics. They are baked or fried, stewed as a vegetable, dried and beaten up into a flour or meal, dried in the sun like figs, preserved with sugar and vinegar, or pressed and fermented, yielding a kind of cider. Wrapped in banana leaves and cooked in a fire-pit similar to that used for beans, they have a flavor all their own. Most bananas are used in the cooked form in the tropics, but the one most used in this way is the plantain, which is too coarse and poorly flavored to be eaten raw.

The plantain, or Adam's fig, *Musa paradisiaca normalis*, is a large variety native of India and now distributed in many forms to all parts of the tropical world. The leaves are green, the flowers yellowish-white, the floral bracts violet, and the fruit large, distinctly ribbed, and yellow when ripe, but usually cooked when still green, having in its unripe state an agreeable starchy taste. The common banana found in our markets is really a variety of the plantain and would be rendered more digestible by proper cooking. In East Africa, there are some "cooking bananas" with fruits two feet in length and as thick as a man's arm. A curious species in Cochin China called *Musa corniculate* bears only a single fruit, but it makes a meal for three persons.

The so-called "fruit bananas," cultivated for commercial purposes or for local consumption in the ripe state, vary greatly in size, appearance, and flavor in the different countries. The best ones are too perishable for ordinary marketing and are obtained only by visiting the regions where they grow. The "Dominico," a short yellow variety much esteemed in Mexico, can be shipped only a few miles; while the best banana in Jamaica, known as the "fig banana" or "lady-finger," — a very small, thin-skinned, yellow variety with sweet, delicate flavor — is practically unknown to our northern markets, although shiploads of bananas arrive continually from Jamaican ports. The same may be said of the "datil," or date banana, and the "manzana," or apple banana, of Cuba, which are highly esteemed in their own country but not exported.

Most of these fruit varieties are forms of *Musa paradisiaca sapientum*, to which group our common yellow "Martinique" variety belongs. Red varieties are no better in flavor but usually require more care in shipping. The ancient Hawaiians recognized at least twenty varieties of this group, all brought with them at an early date, along with the sweet potato and the bread-fruit, from their primitive home in the South Pacific.

Some of these varieties are very curious. In one, the bunch of fruit is small and ripens within the stem of the plant; another bears fruits shaped exactly like a hen's egg; in another the young fruits are red instead of green; and still another variety bears from two to four bunches of fruit to the plant instead of the usual single cluster.

Musa Cavendishii, a distinct species from China, has small fruit, but it is a good shipper and the plant, being small, endures cold and stormy weather better than almost any other species. It is the standard banana cultivated in Hawaii, having been introduced from Tahiti about 1850. Its leaves are red-spotted, the floral bracts reddish-brown, the flowers yellowish-white on drooping spikes, and the fruits fragrant, seedless, and of fairly good flavor. The "enana" variety so common in English markets belongs to this species.

Although a few plantains reach the vegetable markets of Louisiana and Florida, we are chiefly con-

cerned with the cultivation of the ordinary banana of our northern fruit-stands, grown in large commercial plantations in Jamaica, Costa Rica and other parts of tropical America. It is known by several names, among them, the "Martinique," the "Jamaica," and the "Bluefields." In Jamaica, it is called the "Dominica," while in Cuba it is known as the "Johnson." Being large, handsome, of fair flavor, easily grown, and probably the best shipper, this variety has held its own against all rivals even though the "Red Jamaica," or "Baracoa," looks better and many varieties from India and elsewhere are more finely flavored.

The banana plantation must be located on low ground near the coast or in a rich valley, where there is plenty of water and deep soil rich in humus. Drainage is also important, and this is often effected by numerous deep ditches running at right angles through the plantation. Grass is kept down by cultivation and by sowing cowpeas and other green manures. Fortunately, there are few diseases that affect the plants when once established under proper conditions.

Seeds being unknown in the varieties ordinarily grown, the plants are propagated by suckers or cuttings from the rootstocks, which are set out fifteen feet apart each way or in blocks of four planted twenty-five feet apart. The first crop of fruit appears on the new plantation in from twelve to eighteen months, after which there is a regular supply from plants produced by suckers until it seems wise, after ten or a dozen years, to discard the old stock and begin with fresh cuttings again. A convenient method of assuring a uniform succession of crops is to keep about four plants of various sizes in a hill, and, when the oldest matures its bunch of fruit and is cut away, to train up a new sucker to take its place eventually.

The banana is a voracious feeder and the most prolific fruit-bearing plant known. A single bunch grown on one stalk may contain over one hundred and fifty fruits and weigh as much as eighty pounds. With six hundred to eight hundred plants to the acre, it is easy to estimate the enormous yield, amounting to forty-four times that of the potato and one hundred and thirty times that of wheat.

When the fruit is fully grown but still green, the clusters are cut and shipped northward as quickly as possible; good organization and complete telephone connections between the docks and the plantations being essential to success in this particular. On the ship, they require good ventilation and a moderate temperature, never falling below 50 deg. F., which would injure their flavor and prevent them from ripening properly.

In the winter, the storage rooms and docks must be artificially heated. If needed at once for the market, they can be ripened in two days over charcoal fires in tightly sealed rooms. Unlike many fruits that are gathered in the green state, the variety of banana which we buy at the fruit-stand differs little in taste from the same variety ripened in the tropics. But it is often grown on very poor soil for home consumption, thus improving its quality while reducing its size. A process recently invented for drying ripe bananas should prove of great value, and this would also enable the northern buyer to secure the very best varieties of fruit known.

The introduction of the banana into the United States is comparatively recent. In 1804, the first lot of only thirty bunches was imported, and, in 1830, the first full cargo of fifteen hundred bunches arrived in New York harbor from Baracoa, Cuba. The first bananas from Jamaica were introduced in 1869, and since that time the industry has steadily increased to enormous proportions, about two hundred steamers being engaged in the trade. Many of our bananas still come from Jamaica, but more of them from Central America.

The starch in the green banana changes into sugar as it ripens, and the pulp is rich in mineral salts, as well as free from germs because enclosed in a protecting skin. Ripe bananas are said to contain 12 per cent of digestible food. A man would have to eat eighty a day to obtain sufficient carbohydrate food, and twice that number for the necessary proteins. This explains the unusual abdominal expansion in regions where the banana is the principal food.

A great deal has been written about the digestibility of the banana as we buy it, which would have been unnecessary but for the experience and observation of a good many discerning persons. When eaten before thoroughly ripe or gulped down without mastication, it is not surprising that it often causes discomfort. Mixing it with bread or cereal prevents it from forming a mucilaginous mass in the stomach and thus promotes its digestion, while baking it quickly in the skin until soft and juicy renders it perfectly harmless for most persons.

Recent Studies of the Venomous Snakes*

New Light on Their Behavior in Attack and Defence, and on the Chemistry of Their Venom

By J. Beyer

DURING the past thirty years I have made many observations upon venomous serpents, have experimented with snake venom and its constituents and have endeavored to determine its effects upon both cold and warm-blooded animals. I have experimented mainly with cross adders and sand vipers. At first I observed the serpents in a state of freedom from a suitable distance, and found that on sunny mornings they leave their nooks of retreat in holes in the earth, etc., very early, taking up a position in damp but sunny edges of the forest and in meadows where they watch for their prey, quickly taking flight, however, when there is an unfavorable change in the weather or when disturbed by men or hostile animals. Snakes are less lively and less eager to bite when the temperature is low and when they are sated with food; when they are surprised by their enemies, they quickly become worked up into a state of rage and eagerness to attack. They usually allow men and the larger animals to pass in peace and only attack them when alarmed by their close proximity. The act of biting is preceded or followed by a brief warning hiss. . . . One day I caught a large water frog and took it to a pond where I knew that a large copper-colored adder was in the habit of sunning itself. I allowed the frog to hop down at a distance of about 30 cm. from its enemy which it spied at once. Trembling in every fiber it began to utter a long-drawn complaining croak and moved toward the adder with quivering limbs. The coiled adder hissed, thrust out its tongue, drew its lifted head backward and, moving the upper ring of its body, buried its fangs in the left breast of the frog. The sound of the stroke was like that of a piece of paper through which a pen is thrust. By means of a jerk the snake then let go of the body of the frog, placed itself again in a position of watchful waiting and uttered a hiss. The frog at once began to swell in the vicinity of the bite and died, exhibiting symptoms of paralysis. The holes made by the fangs were recognizable by two blackish spots which visibly grew larger; at the end of about two hours the corpse of the frog was uncommonly bloated, slimy, and dark gray in color. The adder, meanwhile, had plunged into the pond where it swam rapidly away with its head above water.

I next proceeded to catch various small animals, such as mice, hedgehogs, sparrows, crows, etc., and used them to experiment with snakes enclosed in a large glass box. The adder nearly always strikes its fangs into the soft breast of its victim, then stares stonily at it, holding itself in readiness for a second stroke, and not proceeding to eat it until the quivers of death have entirely subsided. Nearly all the smaller animals seem dazed by the eye of the adder and not only do not seek to flee, but even move towards the dreadful enemy with trembling limbs and cries of alarm. After receiving the death wound most of the victims show signs of paralysis and loss of consciousness—death usually occurring in a few seconds. One hot August day I was able to observe the behavior of the well armed hedgehog toward an adder. The hedgehog was a strong, hungry and very active animal, while the adder was an old female which moved excitedly about in the box when it saw its greatest enemy nearby. For a short time the hedgehog lay still in the box while the snake coiled hissing in a corner; then the hedgehog carefully concealing its snout and its legs moved toward the snake. It then crouched flat against the ground and whenever the snake attempted an attack drew itself together at the proper moment so as to present its quills to the snake, which it soon succeeded in touching. The serpent then dashed blindly into the quills and raised its bleeding head and tried to flee, but the hedgehog instantly seized it by the neck and bit its head off clean. It then proceeded to devour the lashing body of the snake leaving the head untouched and always carefully avoiding it in its rambles about the cage.

Those animals which eat snakes, such as the hedgehog, the fox, and some eagles, appear to have an instinctive fear of the deadly properties of snake venom and to know how to distinguish between poisonous and non-poisonous kinds of serpents. They never eat the head.

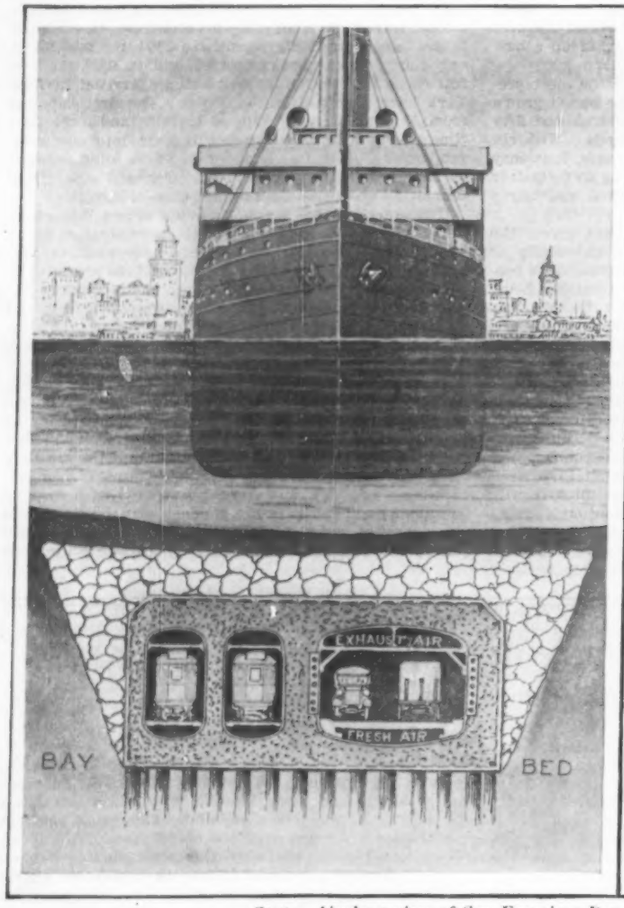
Later I injected snake venom into a hedgehog, which promptly perished like all other animals so treated, showing that it was not immune. Snakes do not bite their victims as other animals do which press the parts of the body of their prey between the jaws and then bite, but open the mouth to its full width and then strike with the upper jaw, which is movable somewhat like a winch with a sliding rod. The blow is made with the firmly fixed fangs embedded in its upper jaw and the lower jaw exerts little or no pressure. The wound never shows any damage done by the teeth of the lower jaw. After the blow has been given the snake jerks its fangs free with a swing of the head. I then endeavored to collect as much of the venom as I could, so far as possible from large and hungry snakes. By a blow upon the neck, I made a snake motionless, grasped it in a cleft stick, thrust a cylindrical lamp chimney into the mouth and exerted pressure upon the eyes with a small wooden fork. In this manner I obtained the two drops of poison of varying size, consisting of a yellow fluid with a nauseating odor, which promptly dried into a yellow mass in the air and which in this condition can be kept containing its deadly powers for many years. The venom is in a uniform body, it consists of albumen (venom globulin and venom peptone), together with salts of calcium magnesium and other elements. Cobra poison is quite different from that of the adders. I took a glass of distilled water and shook some of the snake venom into it. The yellow powder at once lost its color, falling to the bottom as a white precipitate consisting of the venom globulin. This is an insoluble substance which prevents the coagulation of the blood. For this reason, not only the non-assimilated blood issues from the wound but all the capillaries in the victim's body pour such blood into the tissues. The venom globulin is not able to penetrate tissues and membranes (intestinal walls) and for this reason when it is swallowed it passes through the body without doing any harm.

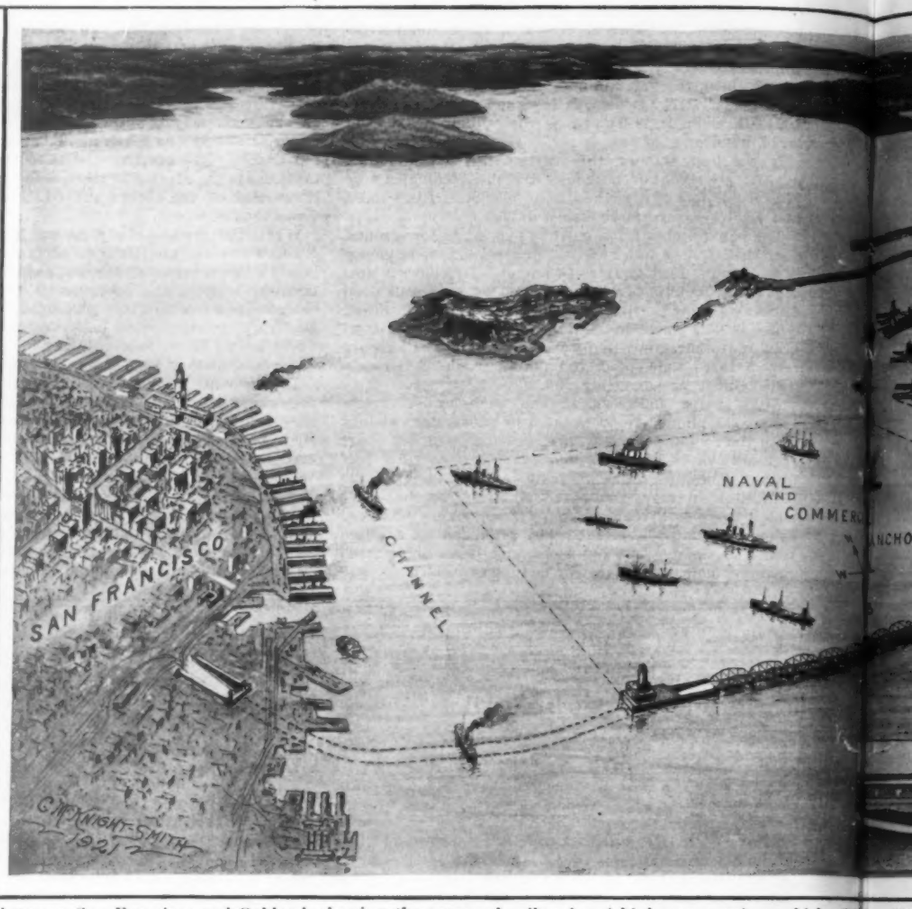
The venom peptone is soluble like all of the alimentary juices. Animals which were given water containing the venom peptone died very shortly from severe intestinal disturbance. The venom peptone at once penetrates the intestines, the skin, and all tissues and membranes, causing them to swell and decomposing them immediately, inducing putridity. It also immediately affects those parts of the brain which govern the respiration, on which account animals poisoned with it die from suffocation with symptoms of paralysis. In all experiments and cases of accident it is important to know what part of the body was exposed to the venom and what sort of poison was present in predominating quantities, since upon this depends the degree of danger. In the various venomous serpents the percentage of these two kinds of poisons is very variable; while the venom of the cross adder contains about 45 per cent of the peptone and 55 per cent of the globulin, that of the rattlesnake contains about 50 per cent of each, while that of the cobra contains only 20 per cent of the globulin and 80 per cent of the peptone.

On this account the poison of the cobra and of the Indian haje whose greater part consists of peptone, is particularly dangerous, since the poison at once penetrates all membranes of the body, causing death. The wounds at once begin to be painful, since the venom immediately penetrates. Most dangerous of all, as a rule, are wounds made by snakes in captivity, since their glands are apt to be over full of poison. The more excited, heated or fatigued the victim, the more rapidly the venom works, causing a struggle for breath and paralysis of the brain.

The process of healing is extremely difficult and tedious in case of recovery, since the dead and decomposed tissues find it hard to renew themselves, and on this account the wounds should have the poison pressed out or sucked out as much as possible, and the area of the bite cut out. Snake venom is neutralized by alcohol and alcoholic products, and by vinegar, etc. When snake venom is mixed with a gram of ordinary water containing an equal weight of potassium permanganate, its effectiveness is entirely destroyed. Animals can even be inoculated with this mixture without injury, not even any temporary disturbance being usually visible.

*Translated from Kosmos (Stuttgart) for Scientific American.





Center: **Airplane view of San Francisco Bay between San Francisco and Oakland, showing the proposed railroad and highway crossing, which will ... a 350 ... view of the bridge portion of the crossing ... the ...**

Crossing San Francisco Ba... B...

Engineers Propose a Six-Mile Vehi... and ... San Francisco and ...kland, ...

IT will take the future historian to appraise at its full value the influence which the motor car has exerted in the development of transportation facilities. What it has done in stirring up the country to build a system of highways is well known; but not so well understood is the influence of the motor car in promoting the construction of great bridges and tunnels which, but for this urge, would have remained upon paper and in the shadowy realms of theory for many years to come.

Here in New York the automobile interests are as strong as, if not stronger than, any other in the promotion of the great suspension bridge whose construction will shortly commence across the Hudson River. Indeed, it is planned to complete the upper deck, which will be used for motor and general vehicular traffic, first, and throw it open at once to the public. Statistics of travel show that, from automobile tolls alone, there will be available a sufficient revenue to cover all the fixed charges on this great structure.

And now it appears that, on the opposite side of the continent, where, at San Francisco, they possess natural harbor facilities, present and prospective, which match if they do not exceed those of New York, the growth of automobile traffic has been such that the motor car interests have combined to urge the carrying through of the construction of a great highway and railroad structure extending for six miles across the Bay from Oakland to San Francisco. It seems that there is on the Oakland and Alameda side of the bay a congestion of automobile traffic which at times entirely swamps the existing ferry boat service across the Bay to San Francisco. Indeed, the situation here is similar to that presented on Sundays and holidays along the western bank of the Hudson River and it is claimed by those who have had experience at both localities that the San Francisco problem is just as serious as that at New York. Be that as it may, the Motor Car Dealers' Association, the Associated Newspaper Committee, and the General Bridge Committee, united their forces and invited J. Vipond Davies, who was associated with Mr. Jacobs in the construction of both the Pennsylvania and the Hudson tunnels beneath the Hudson River, and also Ralph Modjeski, the well-known bridge engineer, to visit San Francisco, look over the various plans, both bridge and tunnel, for crossing the Bay, and make their own suggestions as to what would be the best solution of this great problem. This report was made during the past summer and the illustrations accompanying the present article are based upon that report. The engineers state that the main question is the adoption of a plan which will meet with the approval of the War Department; which will represent the most reasonable cost of production; which will combine reasonable cost of operation and maintenance; entail upon the traffic the least measure of expense in operation and the least inconvenience; and which will present the least permanent interference with navigation.

Route of the Proposed Crossing

The line of the proposed crossing of the Bay commences at any convenient point between Mission Rock and Petrel Point in San Francisco, and extends thence due east to the boundary line, north and south, between the counties of San Francisco and Alameda. Here it enters the property which has been set aside for a proposed navy base. It then extends across the westerly portion of Alameda Island to the Oakland estuary near the foot of Broadway, Oakland, from which point excellent distribution of traffic can be made into the street system of Oakland. The airline distance between the City Hall, San Francisco, not far from which the crossing terminates, and the City Hall of Oakland, is 8.13 miles; and the driving distance by motor car is 9.38 miles. From the terminal point in San Francisco the line will descend in tunnel and, swinging to the left, will pass beneath the main ship channel between the upper and the lower bay. It will descend to a depth which will permit of fully 40 feet of water in the channel at low tide, and this full depth will be available for a width of 1500 feet in the channel. The tunnel will then rise on such a grade as will give an additional width of 2500 feet, in which the water depth will be 20 feet at mean low water. After crossing beneath the channel, the tunnel will emerge above the level of the water, and the structure will pass on to a bridge, which will extend across the comparatively shoal center portion of the bay until, near the opposite shore, it reaches the westerly channel at the 30-foot contour line. Here the crossing will consist of a concrete-pile-and-slab-deck structure, which will extend for 3600 feet across the channel. From this point across the Navy Yard site and Alameda Island, the crossing will be a fill or embankment.

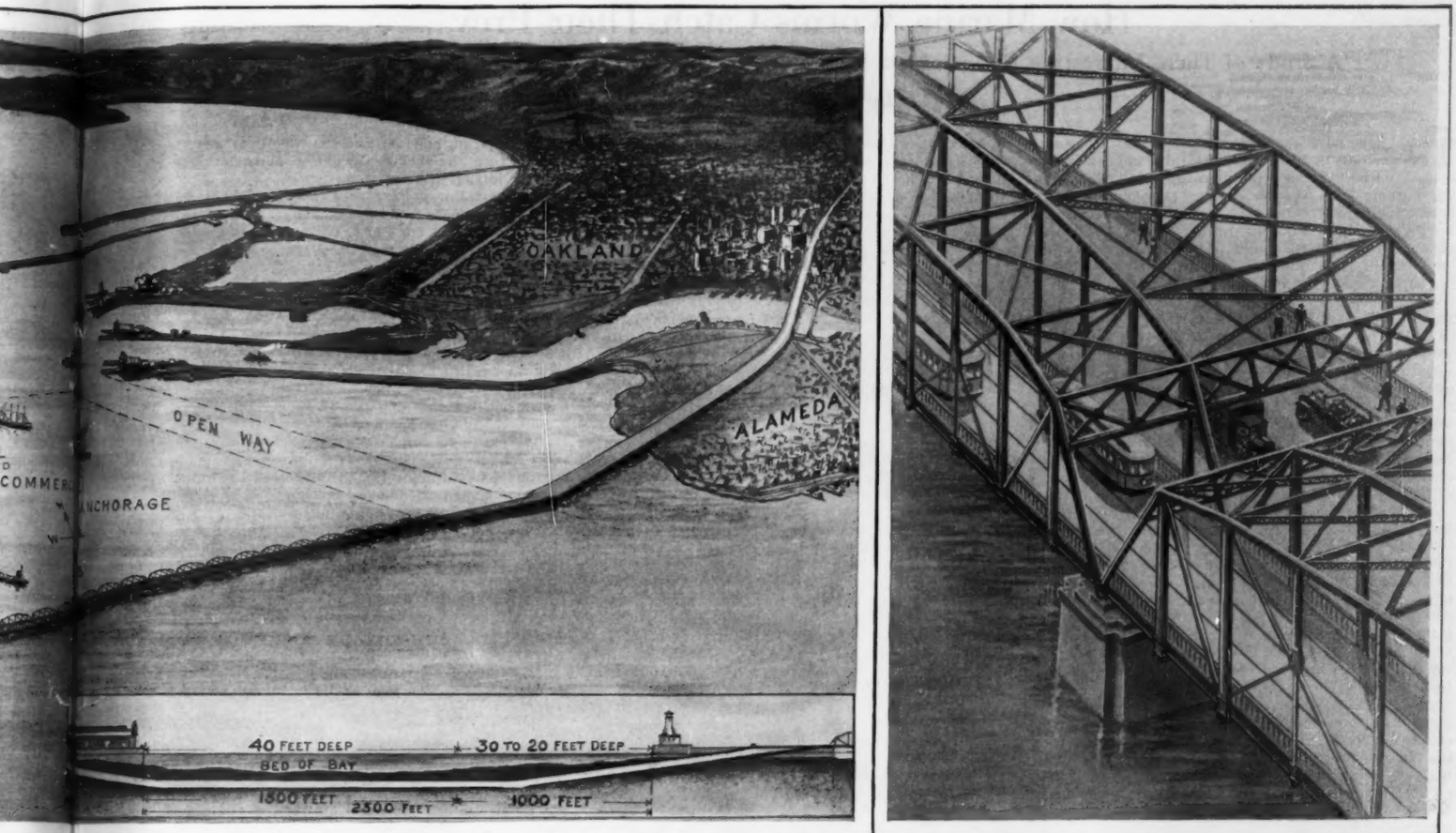
Type of Tunnel Construction

The engineers offer two types of tunnel construction ... both of which are feasible for the San Francisco chann... crossing. One system, as shown in our illustration, co... sists of a large and heavy rectangular cast iron tub... which would be built in sections and would rest upon ... continuous foundation of piling. Within this tube wou... be three cast iron tunnels, one containing a 20-foot roa... way, and each of the other two carrying a railroad trac... The three tunnels would be separate and embedded ... the mass of concrete with which the whole of the out... casing would be filled.

The alternative method to this is the well-known ci... cular shield-driven tunnel, consisting of a circular ca... iron shell with an interior line of concrete. This is th... type which has been used in the East River and Hudso... tunnels at New York.

The Question of Ventilation

The engineers express no anxiety as to the problem ... ventilation. This is due largely to the fact that the... have at their command the results of the elaborate test... which have been carried out to determine a satisfactor... system of ventilation for the vehicular tunnel benea... the Hudson at New York. These tests have been di... cussed in previous issues of the SCIENTIFIC AMERICAN. They were made in cooperation with the United State... Bureau of Mines, the Physiological Department of Ya... University, and the Engineering Department of the Un... versity of Illinois; and it was found that, by means of ... system of properly designed ventilation, the dangerou... gases could be diluted to a point where they would b... harmless. The method proposed for the San Francis... tunnel is that known as "transverse application." Thi... consists in blowing in fresh air at the roadway lev... throughout the whole tunnel section and removing th... foul air through continuous openings at the roof. Thi... has the advantage of removing the gases by the shorte...



which will ... a 3500-foot subway, 11,500 feet of bridge, 3600 feet of pile trestle, and a 12,000-foot fill. *Left:* Cross-section of subway. *Right:* Perspective detail
... crossing, ... the roadway, footwalk and two railway tracks

...co Bay Bridge, Fill and Tunnel

...ile Vehicular and Railroad Structure Joining ...isco and Oakland, California

...oute to the ducts, which is, of course, in a direction ...ansverse to the direction of traffic. It avoids any draft ...owing in either direction along the axis of the tunnel. ...the opinion of Mr. Davies, the length of the San Fran... ...sco tunnel comes well within the practicable limit for ...afe and thoroughly satisfactory ventilation. At the outer ...d of the tunnel, where it rises above the water surface, ...ere will be erected a combined power station and light... ...use, the latter serving to mark the limits of the channel. ...the former will be installed the ventilation machinery.

The Great Central Two-Mile Railway Bridge

The next 11,500 feet of the crossing will consist of about ...ty 300-foot truss spans which will carry two railway ...cks, a 40-foot roadway, and a sidewalk. The general ...aracter of the trusses and the appearance of the road... ...ay are shown in one of our detailed sketches. It is not ...ticipated that there will be any unusual difficulties en... ...untered in this part of the structure. The water is ...mparatively shoal, and the sub-structure will consist of ...ncrete piers sunk either to bedrock or raised upon piling ...iven to a firm footing. The last pier of this section will ...placed at the edge of the open waterway which ex... ...ds parallel with the county line between the counties ...Alameda and San Francisco. From this point for the ...xt 3600 feet the structure will consist of concrete piles ...pped by reinforced concrete slabs which will form the ...perstructure for the roadway and railway tracks. From ...e end of the pile trestle the structure will consist, as we ...ve said, of a great fill 12,000 feet, or over two miles in ...gth. It will be noticed that this fill will cross the site ...the proposed Alameda naval base. The engineers state ...t if this site should ever be utilized as a naval base, ...d if the Navy Department wished to connect the two ...tions of the areas after they have been filled in and ...laimed from the Bay, the highway and the railways ...the fill could be roofed over, and the filled lands graded ...on both sides. In other words, the structure could be made a depressed subway across such portions of the land as might then be found desirable.

Cost of the Structure

The engineers estimate that the total cost of this vast project would be forty million dollars; of which thirty-five millions would be for actual construction, engineering, and administration, and 4,820,000 dollars for land damage to property and interest on cost of money. The annual fixed charges at six per cent would be 2,400,000 dollars. The proposed toll per passenger would be five cents, and 75 cents for each vehicle, which is less than the present automobile ferry toll. To this would be added receipts from railroad freight movement and from certain concessions such as for electric ducts. The aggregate receipts from these sources during the first year of operation, it is estimated, would be 1,592,500 dollars, rising to 2,850,000 dollars in the third year and 3,630,000 dollars in the fifth year.

Fire Tests of Building Columns

IN cooperation with the Associated Factory Mutual Fire Insurance Companies and the National Board of Fire Underwriters, the Bureau of Standards has conducted a very thorough investigation of the fire-resistance of building columns and has recently issued Technologic Paper No. 184 on this subject which is for sale at 75 cents per copy by the Superintendent of Documents, Government Printing Office, Washington, D. C.

The fire exposure test was produced by placing the column in a gas-fired furnace at the same time the pre-determined working load for the column being maintained constant during the test. In certain cases not only the resistance to fire but resistance to fire and water was investigated. In this case the column was loaded and exposed to fire for a predetermined time after which the doors of the furnace were opened and a hose stream applied to the heated column, the severity of the test being regulated by the degree of resistance developed by the corresponding type of column in the regular fire tests. The paper reports 91 fire tests and 15 fire-and-water tests.

In the case of columns protected by a fire-resisting material, the latter was obtained from the main producing regions of the country, in order to secure truly representative material. Care was taken in erecting the columns and coverings to duplicate as nearly as possible actual building practice. The test results are presented in 12 tables and 128 figures and diagrams, the latter comprising views of the columns before and after test, the time-temperature curves for the furnace and numerous points on the test column as well as unit deformation with corresponding average column temperature curves.

The results are summarized in terms of hours and minutes of fire resistance offered by the different types of columns and protection. The resistance period is taken as ⅔ of the average time to failure in the fire tests, the deduction being made to allow for incidental variations in material and workmanship of columns and coverings as tested and as installed in buildings and also for differences in load and fire conditions.

The resistance periods thus derived vary from 10 minutes for unprotected steel columns to 8 hours for similar columns covered with a 4-inch thickness of concrete made with fire-resistance aggregates and reinforced concrete columns made with the same aggregates.

Freak Boiler Explosion With a Man Inside

ONE of the most unusual or "freak" boiler explosions that has ever been recorded actually took place at a plant in New Jersey, near Newark.

The boiler was of the stationary locomotive type and had been out of service a long time. At the time of the explosion the inspector was inside the fire box searching for defects, and he certainly found one. He was naturally rather startled to hear a report like the discharge of a cannon and at first thought that a stick of dynamite had exploded. He found, however, that a furnace sheet had ripped open for a length of about 36 inches directly through a weld that had been made in the sheet. The rupture extended about equal distances on either side of the part built up by welding.

The explanation of this peculiar occurrance is thought to be that the sheet had been overheated in the welding process, crystallized, and was therefore under a severe shrinkage strain. The defective part was practically free of scale. The handhole plates at the bottom of the boiler were off, but the manhole plate had been replaced.

The incident is certainly a forceful demonstration of the dangerous stresses that may result from improper heating in the welding process.

How Marine Worms Catch Their Prey

A Study of These Interesting Forms of Sea Life, Which Abound in Great Numbers and Wide Variety

By William Crowder

TO the true naturalist, no creature is ugly. The serious business of his life removes him from the prejudices inspired by superficial appearances. The lay public, however, does not always share this happy indifference. It ofttimes regards as forbidding, and even unworthy of consideration, many animals, which a more familiar acquaintance would reveal to be not only prepossessing, but genuinely interesting. Of those animals universally held in contempt, few are shunned more than the worms. Nor is this aversion entirely without reason. The unwholesome experience of mankind, gained largely through contact with the degenerate forms, has done much to create in his mind an antipathy toward all related members of the family. Consequently, there has been a marked apathy in regard to these creatures, and little, or none, of that interest which ordinarily attaches to the lives and habits of more favored animals has manifested itself generally. Nevertheless, there is much to recommend these lowly creatures to our consideration; and a charitable inquiry of their ways will amply repay the investigator.

By far the greater in number, both in species and individuals, are those worms which inhabit the sea; and it is here that we find every type, from the lowest to the highest, from the most abhorrent to forms exquisitely beautiful, forms which in richness, variety and harmony of color are surpassed by no other animals. All show marvelous adaptations to their environments, many exhibit uncommon ingenuity in the construction of their homes, and not a few betray an intelligence superior to numberless creatures more highly organized. Indeed, the simple organization of the worms, when contrasted with the complexity of the life histories of many of their species, is one of the curiosities of natural science. So involved is the development of some of the most abundant forms that years of research have not yet worked it out. And still the revelation of these curious details is but one of the many features of never-failing interest which entitles their claim to a greater popularity.

It is among the flatworms, the lowest division of the worms, that we find some of the strangest puzzles in the domain of biology. Some there are which begin life as males; later, however, they lose their masculine characteristics and become females. Others, again, seem to have lost all functions of sex, reproducing their kind by the simple process of dividing into several pieces, each piece growing into a perfect adult, which, in turn, repeats the extraordinary process.

The largest of the flatworms, and, for that matter, of all worms, are to be found among the nemerteans, a group characterized principally by the long, protrusible, thread-like proboscis that each individual carries. W. Saville-Kent, the English naturalist, in referring to the length of these worms, says "the so-called India-rubber worm is remarkable for the extraordinary elasticity of its tissues. Black in hue, it lives among the rocks and seaweeds and preys upon small fishes and other organisms. These, being seized by the suctorial mouth, are unable to effect their escape, the worm's body being capable of stretching out to a length of twenty feet or more and playing the captured victim like a living elastic fishing-line until its struggles are exhausted."

The longest nemertean of our shores, however, is the ribbon-worm, *Mecklea ingens*. This animal, so commonly found secreted under stones or buried in the sand between tide marks, often attains a length of more than ten feet, its breadth being an inch or more. But, in spite of its great length, it is capable of contracting to less than a yard. In doing so, however, it loses its flattened appearance and becomes more nearly cylindrical. It is of varying shades of pink or flesh-color, and is one of the rare instances wherein the appearance of the animal is in agreement with its popular name. It has no well defined head or other specialized regions of its body, and is extremely soft and delicate in texture. It can, nevertheless, burrow with great rapidity, which it does with the aid of its proboscis; and it also uses this organ in determining the location, and effecting the capture, of its prey.

And this latter is a sight never to be forgotten. Let me say at once that Mecklea is a cannibal. It, and I here use the neuter pronoun, for the ribbon-worm is a hermaphrodite, it subsists largely on the smaller of its own species, though it will not hesitate to attack other forms as large or larger than itself. When the ribbon-worm comes forth from its hiding-place at night,—for, although it is blind, it can distinguish light from darkness,—it meets scores of other nocturnal prowlers, among which are many of its own kind. As it extends itself with wave-like undulations over the stony bottom, its proboscis constantly darting here and there among the crevices searching out its victims, it suddenly comes in contact with another nemertean out on the same errand. Coming athwart the posterior end of the other, its adhesive probe encircles it with a tenacious hold. In an instant the entangled worm rapidly contracts and expands, executing many convolutions. It realizes its danger. But too late! The other is upon the writhing struggler, and, applying its distended mouth, proceeds to engulf its victim whole. Quite actively does it carry on this horrifying task, until it would seem that if there were no limit to its appetite, there surely must be to the capacity of its digestive tract; yet, steadily and surely, the one passes down the throat of the other until more than a half of its body disappears. Then a curious thing happens.

It may be observed here that the nemerteans have the remarkable power of regenerating lost parts, which thereby enables them to undergo astonishing injuries without fatal results. They can be cut completely in two, and the fore-body will ultimately develop into a perfect individual, while the hind-body will retain its vitality for days before dying. This division of the body can be accomplished by the animal itself, and seems sometimes to occur as a natural process. Now, this is what took place in the above instance with the worm who was threatened with extinction. The time had come when it decided that enough was enough, and, availing itself of this facile method of escape, it constricted its body in the region of its free end and literally parted company with itself and its enemy. But that is not all: Immediately after its escape, it met with another wanderer, and straightaway subjected that unfortunate to the fate which it itself had so narrowly missed!

Now, it sometimes comes to pass that Mecklea devours a worm, such as a nereid, which grows numerous spines or bristles. In this event, these indigestible portions often work their way through the intestinal wall and out of the body. But this is in no wise disconcerting, for the punctures heal rapidly, leaving the nemertean no worse for the experience. Still, even this property of regeneration in nemerteans is surpassed by a lower group of flatworms: the planarians. These animals can be divided not into two, but into several pieces, and each piece will live and function as an adult. On the other hand, if they merely be mutilated, instead of severed, bizarre forms will result from this modified tendency to regenerate.

When consideration is given to the thriving myriads of flatworms that exist, it is quite evident that they are sufficiently endowed with means and ability to secure a plentiful supply of food, but to find raptorial organs and the instinct, even the intelligence, to employ them developed to the *nth* degree, we must look to the marine annelids, the highest of all worms. Here, too, the methods of capture are as unique as the armature is refined. Many of them are equipped with powerful jaws or grasping weapons, and attack their prey openly; others utilize snares or operate devices ingenious as any to be found in nature.

Let us see how the blood-worm conducts this little matter. *Polycirrus eximius* is a big name for this little animal, for it is not over three inches long, but it at least has the merit of being descriptive. It varies in color from amber to a deep crimson, and makes its home in the soft mud just below low water mark. The distinguishing feature in the appearance of Polycirrus is the crown of crowded tentacles which adorns its head. It is composed of transparent filamentous strands which are continuously contracting and expanding. The worm is capable of extending these to several times the length of its body, the while they appear as tenuous as the finest silk, and would be invisible but for the brilliant stream of blood pulsating through them. They serve the double purpose of supplying the animal with oxygen and food.

Buried in the ooze, the body of the worm is completely hidden from sight, but its tentacles ramify in all directions over and under the surface of the substratum. Perchance there comes its way a small crustacean in search of food. Swimming heedlessly, it brushes against the waving strands. Instantly it is arrested in its headlong course, limed like a bird in a fowler's trap, and at once the adhesive toils close in and sweep the luckless swimmer down into the maw of the hidden monster.

Not all the animals the blood-worm catches are swimmers, however; some are burrowers. It sometimes happens, too, that a sturdy creature, such as the young horseshoe crab, plows its way through the mud and strays into the deadly labyrinth. Then comes a tug-of-war. The crab attempts to liberate itself by crawling away,—and is generally strong enough to succeed,—but in the attempt it pulls against the adhering tentacles until their utmost point of elasticity is reached, whereupon they break. And then the little horseshoe resumes its way, trailing behind it a coma of writhing strands.

To exert no more effort in the capture of prey than is required in the normal process of breathing is the ultimate in solving the food problem. This has been attained, nevertheless, by certain tube-dwellers, termed, in the language of science, Serpulids. Furthermore, these oddly endowed creatures have the added gift of beauty, for their variegated colors and their conspicuous corollate gills give them the appearance of delicate flowers. A constant circulation of the surrounding water is caused by the animal within its tube, and these currents produce a vortex which both bathes the gills and precipitates small organisms into its mouth.

These worms are represented in our water chiefly by the species *Serpula dianthus*, than which there is none prettier of its kind. They live in fairly deep water, and are seldom found near the shore unless washed up after a storm. They always build their calcareous tubes on rocks or shells, which objects serve as supports, or bases, to these frail tenements. Serpula, unlike other tube builders,—notably the mason-worms, which construct their houses of agglutinated shell and mineral fragments, and the comb-worm, which cements grains of sand together in mosaic fashion in making its free cone-shaped shelter,— manufactures its own materials. By that mysterious chemistry of the body it converts the compounds of the sea into a structure of imposing excellence.

Nearly all marine annelids have some pleasing feature which enhances them in the eyes of the beholder, but the palm of beauty must unquestionably be awarded to *Aphrodite*, the sea-mouse, a worm whose appearance has excited the admiration of every age. To the untrained eye, however, it does not look like a worm and perhaps therein may lie the secret of its charm. This is unfortunate. Had the early observers of this animal known its identity, it is within the bounds of probability that ere now many other members of the group would have shone in popularity by reflected light. Yet there is another animal which—though unmistakably worm-like in form—in coloration is not surpassed by Aphrodite itself, and is far superior to that individual in organization and intelligence. This is *Nereis virens*, one of the highest of the bristle-footed annelids.

Nereis is the giant of its class, often measuring over eighteen inches. Seen in the clear water of a tide pool, the sides of its iridescent body adorned with gills of pearly pink, it is the verisimilitude of a glittering chain of blue-green opals flanked by precious coral. Every motion is accompanied by a play of brilliant prismatic tints. From under every gill projects a sheaf of bristles reflecting the luster of pure gold. But it is vain to attempt an adequate description of the ineffable nuances, the evanescent hues, that give to this creature its strange beauty. Graphic representation itself can never reproduce the charming colors caused by the diffusion of light on those translucent textures.

In these worms the sexes are separate, the males being much smaller than the females, and are less often seen, except during the mating season, at which time they swarm the waters at night in enormous numbers. The females make interesting aquarium pets, and they can be induced to come from their retreats to be fed by hand.

When young, Nereis sometimes is found occupying a shell in company with a hermit-crab. When the latter chances to come upon a morsel of food, such as a fragment of carrion, the worm concealed in the shell seems at once to become aware of the fact, and its head makes an appearance at the opening, under the fore-body of the crustacean. Then, becoming bolder, it extends itself and seizes a part, or all, of the other's meal, and withdraws into the shell to consume its pilfering at leisure.

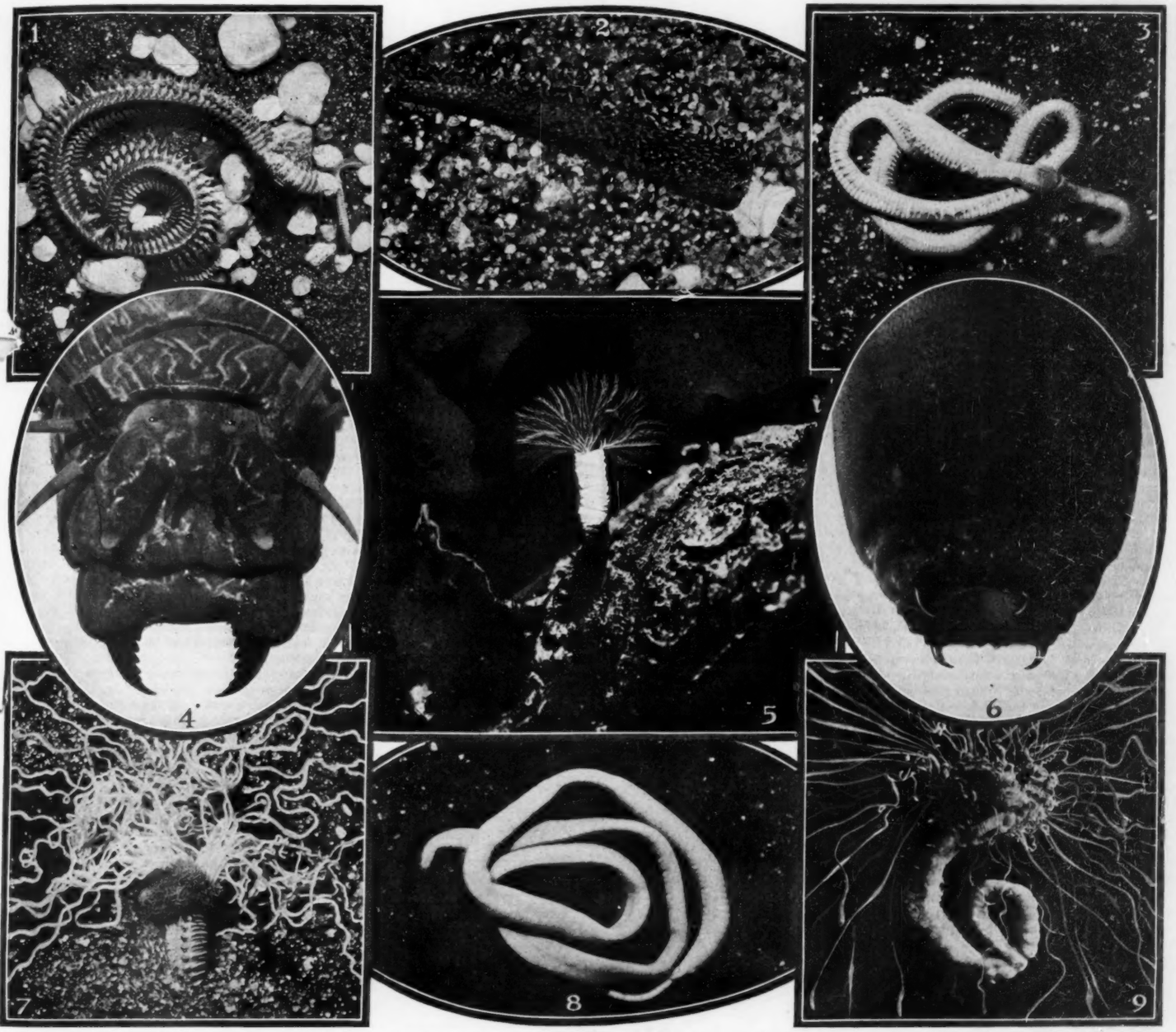
The jaws of Nereis merit attention. Of a hard horny

composition, somewhat like a pair of serrated ice tongs in outline, they are attached by powerful muscles well back in the throat. The creature has well developed eyes and numerous feelers, or sense organs, and when it comes into proximity with food or enemies (it is chiefly carnivorous, but will eat plants on occasion), it everts its armed pharynx much as one would turn the finger of a glove inside out. This action of bringing these formidable weapons into play is accomplished with lightning-like rapidity.

made a desperate onslaught. Pouncing upon the newcomer, which on its part was possessed of no inconsiderable strength, she, with the sheer force of her terrible jaws, bit it completely in two. Needless to say, she then proceeded to devour the crippled victim.

Much more could be said of her other activities, of how she prepares her home, of how she conducts her courtship, of how she brings her progeny into the world—but, as Kipling would say, that is another story, which would take up much space in the telling.

Tests have shown that the tube transmits vibrations better than a solid needle. Also, the reduced weight means a tremendous saving in energy. A phonograph record has to move the needle often as many as 5,000 times per second in reproducing the tones of the human voice or musical instruments. Replacing the solid needle with the tubular or Pentone needle is like substituting the lightness of a bamboo walking stick for the weight of a baseball bat. The lighter needle does not wear out either its point or the record, as



1: *Nereis*, the sand-worm, attacking a smaller annelid. This creature is fierce, active and voracious, and will not hesitate to attack animals larger than itself. Photograph taken through the water. 2: *Cistenides*, the cone-worm. The remarkable structure with which this worm encases itself is fashioned from grains of sand cemented together in a single layer. The animal moves from place to place by pulling itself forward with the aid of its "comb," shown at the extreme right end. 3: *Glycera*, the four-jawed worm, digging its way into the sand with its protrusible proboscis. 4: The jaws of *Nereis*. These formidable weapons are normally carried in the worm's throat. This latter, however, is eversible, and can present the jaws instantly. Enlarged about five times. 5: *Serpula dianthus*, a tube dweller. The worm in this picture has built its home on the empty shell of a whelk. All that is visible of the animal itself is the gorgeous crown of feathery gills which projects from the top of the tube. 6: The jaws of *Glycera*. The four jaws, or hooks, with which the animal seizes its prey are located on the end of its protrusible proboscis, which organ it is capable of projecting more than half the length of its body. 7: *Amphitrite*, the tufted-worm. This animal captures its prey by the numerous tentacles which surround its head. 8: *Meeklea*, a nemertean worm. As shown here, it is contracted; it is, however, able to extend itself to several times this length. These are the largest worms known, full-grown specimens often attaining a length of more than eighteen feet. Its proboscis is here shown partly extended. 9: *Polycirrus*, the blood-worm. These brilliant worms trap their victims much as a spider does its prey; but instead of making a web, they use their crowded tentacles

Worms which inhabit the sea

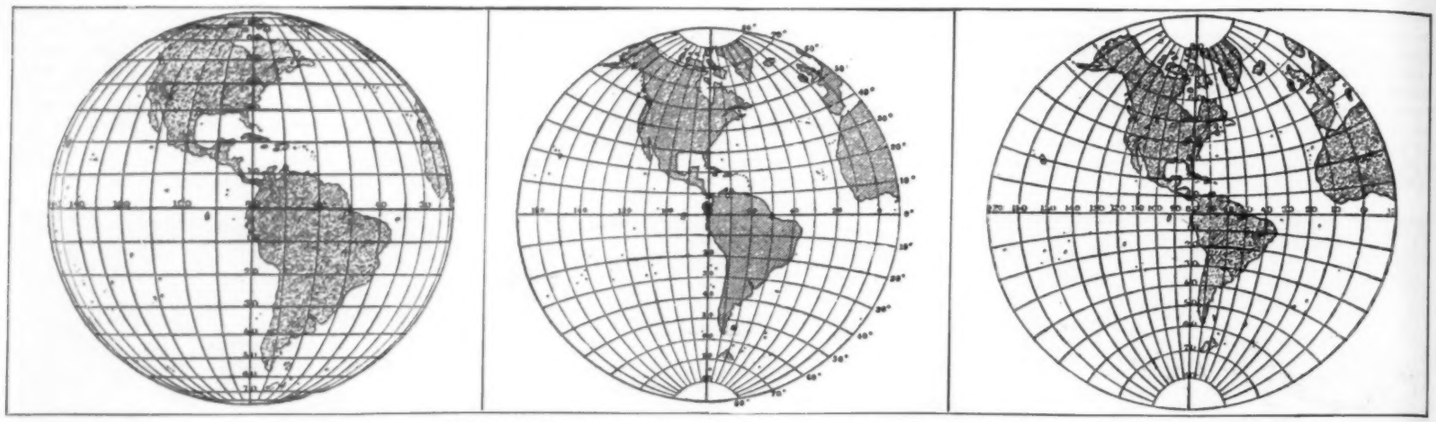
The writer once had under observation an adult female, which on being handled would give his fingers a threatening, but inconsequential, nip. On one occasion he neglected, for some reason or another, to supply her with food for several days. A live annelid fully two-thirds as large as herself, but of another species, was then introduced into her tank. No sooner did Nereis become aware of the other's presence than she

A New Phonograph Needle Shaped Like a Pen

A PHONOGRAPH needle designed on new principles has been invented by William Dubilier, well known for his radio discoveries. In place of a solid shank it has a metal tube. The point is shaped like a pen, but is only one-fourth as large.

the heavier one does. One needle played a total of 502 records.

When the Pentone needle lies on the record as a pen touches the paper when writing, the tones are as soft as those produced by fiber needles and much clearer. If a loud tone is desired, it is only necessary to give the needle a quarter turn. This invention is likely to prove a boon to the phonograph industry.



Left: Orthographic projection. *Center:* Globular. *Right:* Stereographic

Three different schemes of mapping the earth, and their results when applied to a hemisphere

A Map's Other Name Is Ananias

The Various Projections Used in Representing the Earth's Surface, and What They Do to the Facts

By C. H. Claudy

DO you know what a map is? It sounds like a foolish question. You will probably contend that every school boy knows. If pressed for a definition you will probably say "a map is a drawing which exactly represents a portion of the earth's surface, the distances between points upon the map being proportional to distance between the points upon the earth represented" or some similar explanation.

But this is only partly true. There is only one kind of map in existence which will truthfully fit such a definition, and that is a map made upon a globe. No flat map, large or small, "exactly represents" any portion of the earth's surface, and only on a globe are the distances between all points truly proportional to distances between points on the earth represented.

In other words all flat maps are distorted. All flat maps tell only a part of the truth. All flat maps to some extent misrepresent the facts.

This is not due to any lack of moral sense on the part of the map makers. They can't help it. The nature of a globe is such that there is no process by which its surface can be flattened out without tearing, stretching, cutting or compressing. And the earth is a globe (slightly flattened at the poles.

If the earth had happened to be a cylinder, maps would all be truthful. A cylinder can be slit lengthwise and, with the ends removed, its surface flattened out into a square or oblong plane. Had the earth chanced to be a cone, maps of it could be made with perfect accuracy, for a cone, like a cylinder, can be slit and unrolled. Or had the earth been a cube or a polygon, we could make accurate maps of what was upon its many sides.

Nature, however, decreed that the earth should be a globe (nearly). Any flat map we make on paper (as opposed to one constructed on a ball) must represent a part or the whole of this globe. As it is impossible to flatten a part or the whole of a globe without stretching, tearing or compressing, any map of any part or the whole of the globe must be distorted.

We can control this distortion. We can make our maps, for instance, fairly accurate as to the apparent outline of countries or lakes or of oceans. When we look up and see the full moon, it appears to our eyes as a flat bright disk, with markings upon it. If we actually draw these outlines on flat paper, we have a map of the moon which is truthful in outline to what we see.

But the distances, as shown on our lunar map, will not be truthful. Such a map must show the center as distant from the rim of the moon an amount equal to half its diameter, while the center is actually distant an amount equal to one-fourth the circumference. And what is true of the central point as compared to the rim is true of any other two points.

If we make an accurate outline map of North America, so that the countries appear to the eye as they would to an observer on the moon, the distances will not "measure true." And the closer to the rim of our circular map we get, the greater the "compression" and the less the accuracy.

There are a great many methods of making maps—a great many different "projections" as they are called. This name is used for the basis on which maps are made, because "projecting" is the process. Let us suppose a globe of glass, with a tiny but strong light in its center. On the outside of the globe of glass we draw with dark opaque paint, the land surface of the globe. Let us suppose that we curl a sheet of white paper into a cylinder which fits close to the illuminated globe, in such a position that its sides are parallel to the axis, drawn through the poles. Upon the paper, then, will appear a shadow of the countries we have painted on the glass globe. If we now draw these shadows on the paper, and then unroll the paper, we have a "cylindrical projection" of the land contours of the earth. In regions near the equator they are almost, if not quite, accurate. But as we look farther north or south, we find them more and more distorted. And no matter how long our cylinder is, it can never be long enough to get in *all* the map because, as the line joining the poles is parallel to the sides of the cylinder, the polar land (if there is such) could never cast a shadow on the paper.

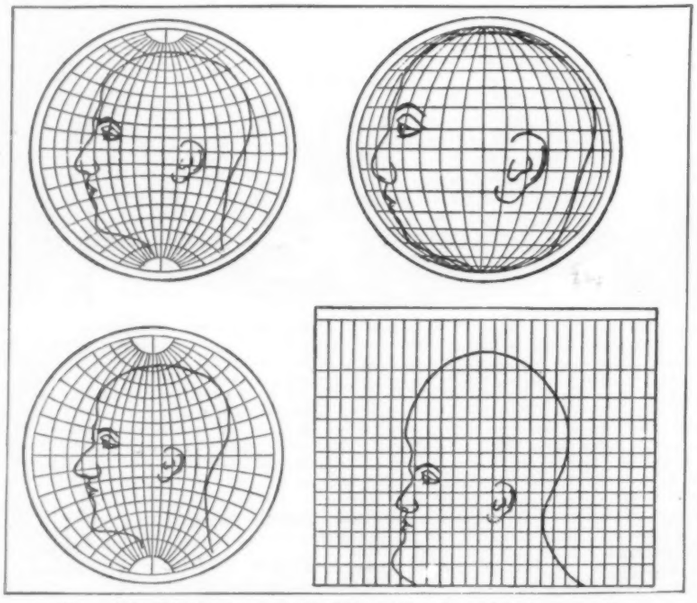
Such a projection is the base of the familiar Mercator projector which is in every atlas. The Mercator projector is what is known as a "conformal" one; the "sketching" of the polar regions is arbitrarily limited, usually to an amount not exceeding the "stretching" east and west.

But the Mercator projection is only one of many. There are many different "projections" because of many different needs of maps for many different purposes. The ideal map, if it could be constructed, would show areas of true shape, areas would have perfect proportion to one another, as in nature, distances from place to place on the map would be truly proportioned to distances between the places on the earth, all great circles on the earth (a great circle is the shortest distance between any two points) would be straight lines on the map, and latitudes and longitudes on the map would be the true latitudes and longitudes of the places on the earth.

No flat map can give all these things in perfection. Many different projections give some of them correctly, the others distorted. We select the requirement we need in a map, and construct our maps accordingly. Thus, in the Mercator projection the great circle is a straight line. The Mercator projection, then, is much used in sailing the seas because it is easy to plot a course on it. It prevaricates badly as to distances; the mariner checks his actual position, and distance of his run, by other means than visual examination of his Mercator projection.

There are many different possible projections. We may consider the earth as a nearly globular body formed of small sections of the bases of cones. We can consider it as having a surface formed of small quadrangles. We can consider a "stereographic" projection, in which our little light in the center of the sphere is moved to the south pole and projects shadows on a plane parallel to the equator. We can make an "orthographic" projection, in which the projection point is infinitely distant—the moon map we drew in imagination early in this story is an "orthographic" one. We can make a "globular" projection, in which the outer meridian and the central one are divided into equal parts by the parallels, which are arcs of circles. This is a much less misleading projection for common use in schools or homes, than is the Mercator projection. In other words it looks and "measures" much more nearly true to nature than the Mercator projection.

All this may appear somewhat difficult of understanding, but reference to the accompanying figures should make it very plain, particularly the four little drawings which show what happens in dis-



Upper left: Globular. *Upper right:* Orthographic. *Lower left:* Stereographic. *Lower right:* Mercator

What four commonly used projections do, as shown on a human head

tortion, when an area is pulled out of shape by one or another projection. Here is a man's head, drawn on a globular projection. If from this we make an orthographic projection, we spread him out, and make him fat and big and bulgy. If we use a stereographic projection, we do not alter his chin and neck and forehead and upper head so much, but we somewhat "mash in" his profile and his lower head. And what we do to him when we put him on a Mercator projection is frightful to behold. We strech him all out of shape.

Yet the "latitude" and the "longitude" of every part of his face is the same on all four projections.

The reader is warned not to consider from this that the globular projection is any better or more accurate than any of the others. Had we at first drawn the head correctly on a Mercator projection and then transferred it to the others by comparing "latitude" and "longitude" of points on the face, we should have other and as drastic distortions.

Of course, for all small areas—a city, a county, half a state, even a whole state if it isn't too big—the flat map is sufficiently accurate in all ways for all practical purposes. One does not need a globe for short distances and small areas. But for large areas and great distances, no map is truthful in all ways, and he is the wise student and the well-informed reader, who either consults a globe when in need of accurate map information or uses his projection, whatever it may be, with a full consciousness of just how and where it distorts reality.

Rock Crystal Balls

By Herbert Whitlock

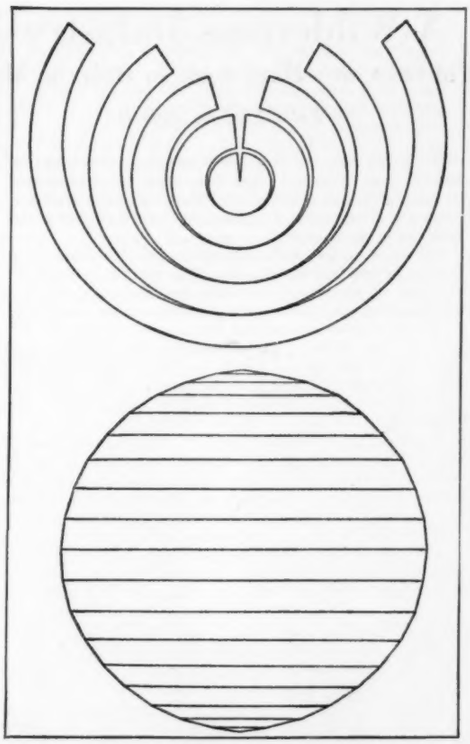
Curator of Mineralogy, American Museum of Natural History

AMONG the semiprecious stones there is none, with the exception of jade, which has been so extensively used as a material for carved objects as rock crystal. From Italy and France have come the graceful vases, chalices, bowls, and drinking vessels of classic beauty, of fine and rich ornamentation; from Russia art objects of more severe and geometric treatment, as well as exquisite statuettes and figurines in this limpid medium; and from the Orient the odd-shaped vases and snuff bottles characteristic of Chinese art.

Among all of these, however, there are probably no series of objects fashioned of rock crystal which are more striking than the spheres made by the lapidary artists of Japan. The best of these are cut from flawless quartz crystals, clear and absolutely colorless, and are usually mounted on bronze wrought into decorative forms, such as dragons, storks, tortoise, and grotesque human figures. The clear, polished ball, contrasting with its dark bronze mounting, is preeminently an artistic object, lending itself with especial facility to the Japanese taste, which sets aside one beautiful thing as sufficient to contemplate and admire in an entire room. Groups of these balls delicately balanced in their mountings have been frequently employed in that land of earthquakes to give warning of shocks, effected by the slight preliminary tremors shaking them from their balanced poises.

Rock crystal spheres have, moreover, been since very acient times the especial stock in trade of the occult foreteller of events. Gazing into the still depths of these bits of earth's clearest substance, these seers of the future, so they tell us, can conjure up pictures impossible of production from commonplace glass. It is this alleged occult property which has raised the rock crystal sphere from a place of preeminent beauty to one of even higher romance and of unreality and woven around it an intricate web of legendary mysticism.

Dr. Dee, a crystal gazer of the seventeenth century, has handed down in his diary a very elaborate and complete description of the methods employed by occulists of that period, which are practically the same as those in use today. The crystal ball is supported upon a background of neutral tone, preferably black, in a room hung with similar draperies and lit only with candles or lamps which concentrate what little light there is present on the crystal. The operator fixes his gaze upon the brilliant spot of light reflected from the polished surface of the crystal until consciousness of his surroundings is replaced by subconscious "vision." It is significant that, in all descriptions of these "visions," what we may call the critical period is marked by the fading away of the image of the ball itself from conscious sight and its replacement by a thin cloud or mist upon which the prophetic "images" appear.



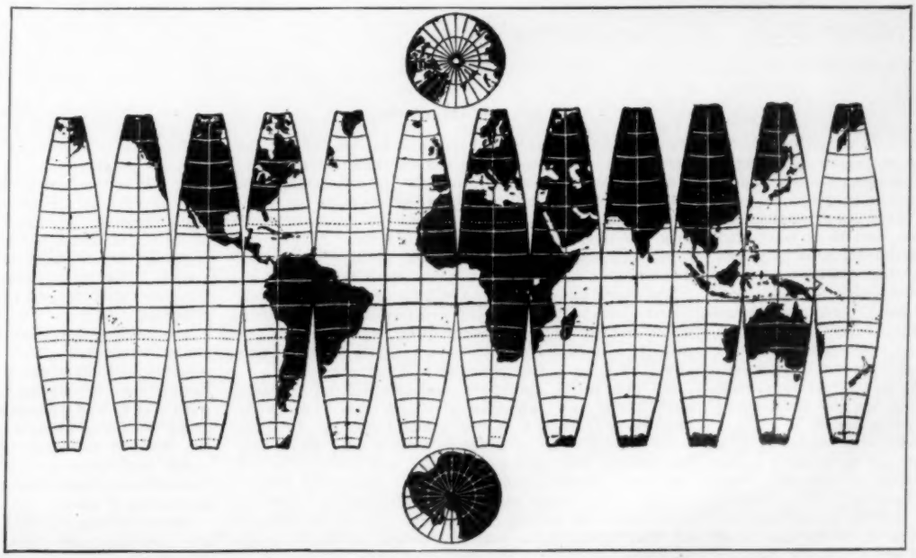
If the earth were made up of a series of conical frustums, these would open out into plane sections to make a map

In a certain sense no less marvelous than the alleged occult powers of the crystal ball are the simple means employed by the Japanese artisans in producing them. This art, which, it is said, has been handed down from father to son for generations, consists of manual dexterity carried to a superlative degree. Armed with only two primitive tools, the lapidary shapes from an angular quartz crystal a sphere of perfect roundness and high polish. The quartz crystal is first roughly shaped to the form of a ball by chipping and abrading it with a piece of steel about twelve inches long and one-half inch wide, which has a concave cutting edge somewhat like a carpenter's gouge. When by means of this treatment the mass has been made round and approximately smooth, a joint of bamboo is used to complete the polishing, quartz dust, which lodges in the pores of the bamboo and, finally, rouge, furnishing the abrasives.

This all sounds extremely simple and no doubt is, to one who is trained to do it, but let the reader undertake it himself if he doubts the wonderful manual skill of these Orientals. Of course, in the lapidary shops of Europe and America where the grinding and polishing of crystal balls are undertaken, the lathe and the casting of just the right curvature for a ball of required diameter render the task infinitely more simple; but even with these aids the production of a rock crystal ball of a diameter of, say, three inches is a matter of weeks.

Inasmuch as the labor expended on a crystal ball of even modest size renders it a very costly object, continues the *Journal of the American Museum of Natural History*, the question which naturally presents itself is how can a purchaser be sure he is buying quartz and not glass? There are two very good ways of distinguishing quartz from its much more plebeian imitator. In the first place, almost every piece of glass large enough for a ball of even small size is reasonably sure to contain one or more round bubbles. Although extremely minute, these may be detected with a good "loop" or hand lens. And inasmuch as quartz never contains round cavities, the presence of these latter will at once stamp the ball in which they are found as spurious.

There is, moreover, a much more exact test, which the writer has found to be applicable to balls from about one and one-half inches diameter up. Quartz has the optical property, called double refraction, of exhibiting two images of everything which is viewed through it in a certain direction. It therefore becomes a very easy matter to apply the test by drawing a cross of fine lines on a piece of paper and then resting the ball on this cross and shifting it until a double image of the lines appears to the eye through the ball. It is impossible for a glass ball to produce this effect. So we come at the end to an actual vision which any one can see by gazing into a rock crystal ball.



When we try to flatten out the spherical earth into a map, this is what happens

Acetylene As Auto Motor Fuel

SWITZERLAND has turned to acetylene for use as a motor fuel, calcium carbide being a native product, while petroleum products are imported. Acetylene, however, has not proved as satisfactory as gasoline, for when F. Haber, a prominent German chemist, visited Switzerland in the fall of 1919, he did not find any cars running on acetylene, all having been reconverted to use liquid fuel. Haber was engaged by the German Government to investigate the possibilities of acetylene as a motor fuel and he conducted a series of experiments. According to Keel, a Swiss authority on acetylene and its use, 1 kg. of acetylene gave as much energy as 2 kg. or 2.5 kg. of benzol, though, the heats of combustion are only as 6:5. The reason for this Haber found to be that there is always an excess of air in the benzol fuel mixture, while acetylene can be burned with its theoretical air allowance. The combustion of benzol was shown to be incomplete; in tests that of acetylene proved to be complete.

As regards the variation of the acetylene percentage in the air mixture, Keel stated that owing to the high pressures, and temperatures produced in the cylinder, the advisable limits ranged from 1.5 per cent to 7.5 per cent of acetylene; Haber sets these limits at 3 per cent and 5 per cent. With mixtures deficient in acetylene, there was noisy back-firing; with rich mixtures, pinking. The pinking is generally ascribed to spontaneous pre-ignition of the mixture by compression.

A Wilderness Industry

How Gold Is Extracted Out of Ores on a Huge Scale in Order to Make It a Profitable Business

By Felix Eugene Averill

"A GOLD MINE" has ever been a phrase to intrigue the imagination and there are few of us but have at some time dreamed dreams of seeking fortune from hidden stores of the yellow metal in the depths of the earth or from the bed of some turbulent far-off stream. Even the highly efficient modern mining and milling operations on immense tonnages of low grade ores, involving the prosaic methods of any up-to-date industry, have not robbed the gold mine entirely of its lure for the imaginative adventurer; and when the mine is located in that part of the world which is known generally among the old timers as the "North Country," the call is irresistible.

But this is the story of the mine, not of the miner. For even among those of us who have to be classed as parlor prospectors and adventurers and whose libraries are filled with stories of the romance of the North, there are few indeed to whom the modern method of extracting gold from its ores is not considered in the light of a mysterious process to be understood only by the professional metallurgist or mining engineer. Among the general public there is probably no modern industry less understood. It is a fact, of course, that the details of the cyanide process of extraction involve many niceties of manipulation, too involved for any but a trained metallurgist or mill man to understand. But in a general way the process is simple enough to be easily understood by anyone who is interested in learning something of this little-known industry.

There are two methods of mining ores that occur in large bodies, as do all of the low-grade ores in the district under consideration. One is the "glory hole" or open pit method and the other is the underground system of "stoping." The "glory hole," as a miner calls it, is an open pit where the ore is blasted out in much the same manner as in the more familiar stone quarry. The broken ore collects in the bottom of the pit from which it is drawn through chutes into cars in the underground workings, which extend below the pits. The drillers, using machines operated by compressed air, work on the steep slopes of the pit wall and place the holes, under the direction of the pit foreman, in such a way as to obtain the maximum effect from the explosion of the dynamite. The drillers stop work and leave the pits at the same hour each day. As soon as the drilling stops the dynamite is brought into the pit and many times the foreman himself undertakes the work of placing the sticks in the holes prepared for them. Sometimes it takes a bit longer than planned to ignite all of the fuses, and he is compelled to seek what shelter he can from the flying rocks as the charges explode in rapid succession. When the first fuse is lighted a siren is sounded at the top of the pit, a warning which is universally heeded, for there is no one so foolish as to neglect putting a safe distance between himself and the glory hole when the "shooting" begins. The shooting of the glory hole is a sight worth seeing—from a safe distance—for great geysers of rock and earth are thrown hundreds of feet into the air and a moment later the sky seems to rain stones.

The main artery of the underground workings is a vertical shaft through which the ore is brought to the surface, and the miners are brought to and from their work in the various levels of the mine. Each level is a system of tunnels, or "drifts" and "crosscuts," extending from the vertical shaft. The drifts in each level are driven under the bodies of ore which lie between it and the level above. Chutes are driven from the drift up to the ore body, and small inclined shafts, hardly large enough to crawl through, serve as means of communication between the "stope" and the drift and carry the compressed air pipes, by means of which the rock drills are operated.

The stope, after work has progressed for some time, is a huge underground cavern. The roof is of solid ore, the floor of ore broken from the roof above, by drilling and blasting away the rock; and the extent and shape of its boundaries are defined by the ore body itself; the walls of the stope following exactly the boundaries of the ore. When the ore body has been exhausted, the stope becomes a large mass or pocket of broken ore which may then be drawn off through the chutes at the bottom, into ore cars in the drifts of the level below.

The shaft itself is much like the familiar elevator of our cities. Like it, it is composed of several compartments, each of which has its car running up and down in the shaft. At the surface of the ground and astride the mouth of the shaft is a great steel structure—the headframe. In it is the hoisting and dumping mechanism and big steel ore bins into which the ore buckets dump their loads. Each car in the shaft is operated by a separate hoist and hoistman. An electric signal system installed at the hoist house and the stations at the various mine levels controls the operation of the cars.

A surface haulage system forms the connecting link between mine and mill, carrying the ore from the headframe bins to the crushers; where the ore is reduced to a size averaging about two-inch tubes. A conveyor belt brings the crushed ore to big storage bins in the mill building from which it is drawn off as required.

The essential steps in the milling or extraction process are these: Grinding the ore to a fine sand; recovery of coarse gold by amalgamation; extraction of fine gold by dissolution in potassium cyanide solution; precipitation of gold from solution and refining.

As just noted, there are two methods of recovery used in our mill: amalgamation and cyaniding. After the ore is crushed to a fine sand in the big steel ball mills enough water is added to form a fluid which may be pumped and carried in pipes and troughs to the various parts of the mill building. This fluid pulp is passed over copper sheets or amalgamation tables on which is a thin coating of mercury. The small particles of "free" gold in the pulp are caught and held by the mercury.

After all of the free gold has been recovered the sand is treated with potassium cyanide which dissolves the gold locked up in the tiny particles of sand. The latter has now become worthless "tailings" and is pumped away to the dump.

The gold is precipitated from the cyanide solutions by the addition of powdered zinc. This precipitate, together with the amalgam scraped from the tables, is sent to the refinery at periods of a week or more.

The refining of the gold from the amalgam is very simple and consists merely in heating the amalgam in a closed retort until the mercury is vaporized and driven off. The gold when removed from the retort is in a spongy condition and is practically pure. This sponge gold goes immediately to the melting furnace, which is ready to receive it, and is melted down and pored into ingots ready for shipment.

The product of the cyanide process, the precipitate, is very impure when it comes from the mill. It is mixed with a suitable flux containing lead oxide and fed into a small blast furnace. Here the lead oxide is changed to metallic lead and filtering down through the furnace picks up the particles of gold in the precipitate and collects in a well at the bottom of the furnace. The impurities in the precipitate combine with the flux to form a fluid slag which floats on the top of the molten lead and is drawn off from time to time. Thus the material in the furnace is finally all reduced to the lead-gold mixture and slag.

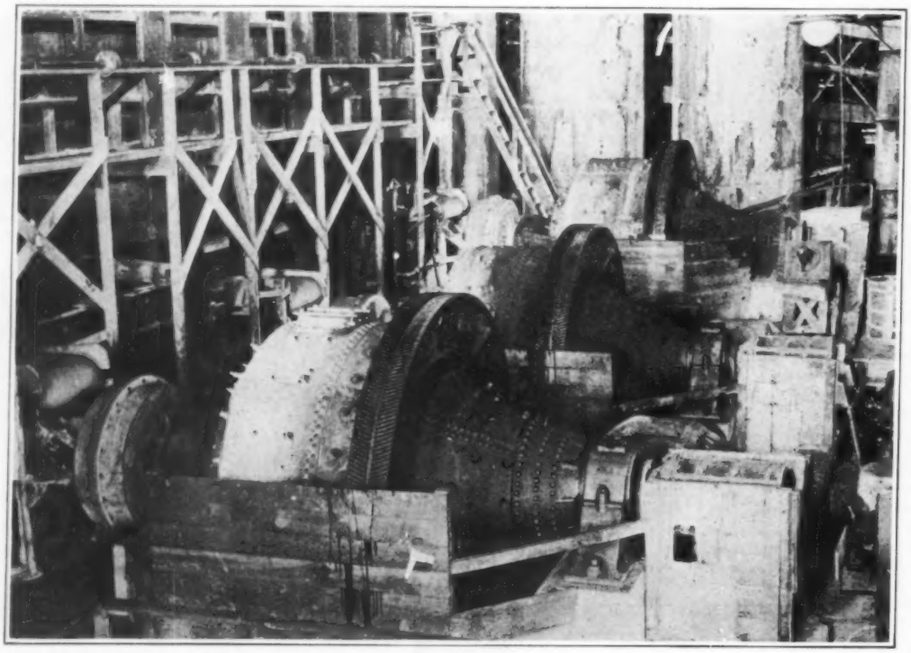
The gold is separated from the lead by oxidizing the latter in a cupel furnace. The lead oxide is drawn off from the top of the molten metal as fast as it forms, until finally only the gold remains. The lead oxide thus formed is ground up and used again in the next batch of precipitate. The gold is broken out of the furnace hearth in a thin slab and melted down in the crucible melting furnace. It is then poured into bars.

There are usually two large bars from a run of precipitate and about the same quantity from a melt of amalgam gold. These bars will weigh over a hundred pounds each, although they are only slightly larger than a common brick. They are made in this heavy form to guard against the possibility of one being "slipped into the pocket" of some zealous "high-grader."

As soon as the gold bars are cooled they are thoroughly cleaned. They are then carefully weighed, after which each bar is stamped with its weight, number and name of the mining company. It is then sewed up in canvas and addressed to the United States mint, which is the destination of all the gold produced at this mine. Although the product of this mine refinery is practically pure metal, it is not fine enough for Uncle Sam's use, so it must again be refined at the mint. Here a small percentage of silver, together with traces of iron, copper and lead are removed.

The assay laboratory is a very important link in the chain of the mining and milling process. Through this medium a constant check is kept on the metal from the time of its discovery in the mine to its shipment to the mint. It is almost impossible, in fact, for any serious "leak" to occur anywhere in the process; for through the work of the assay office it is known almost to an ounce how much gold is taken from the ground, and this estimate must check very closely with the actual shipments of metal.

The gold value of the ore at many low grade mines averages not more than five or six dollars to the ton. When it is considered that coal is worth about this amount at the mine where it is produced it seems re-



The steel mill-bins are at the left, the belt conveyors which feed ore to the mills appear beneath. The tall tanks in the background are slime agitators

A ball-mill installation

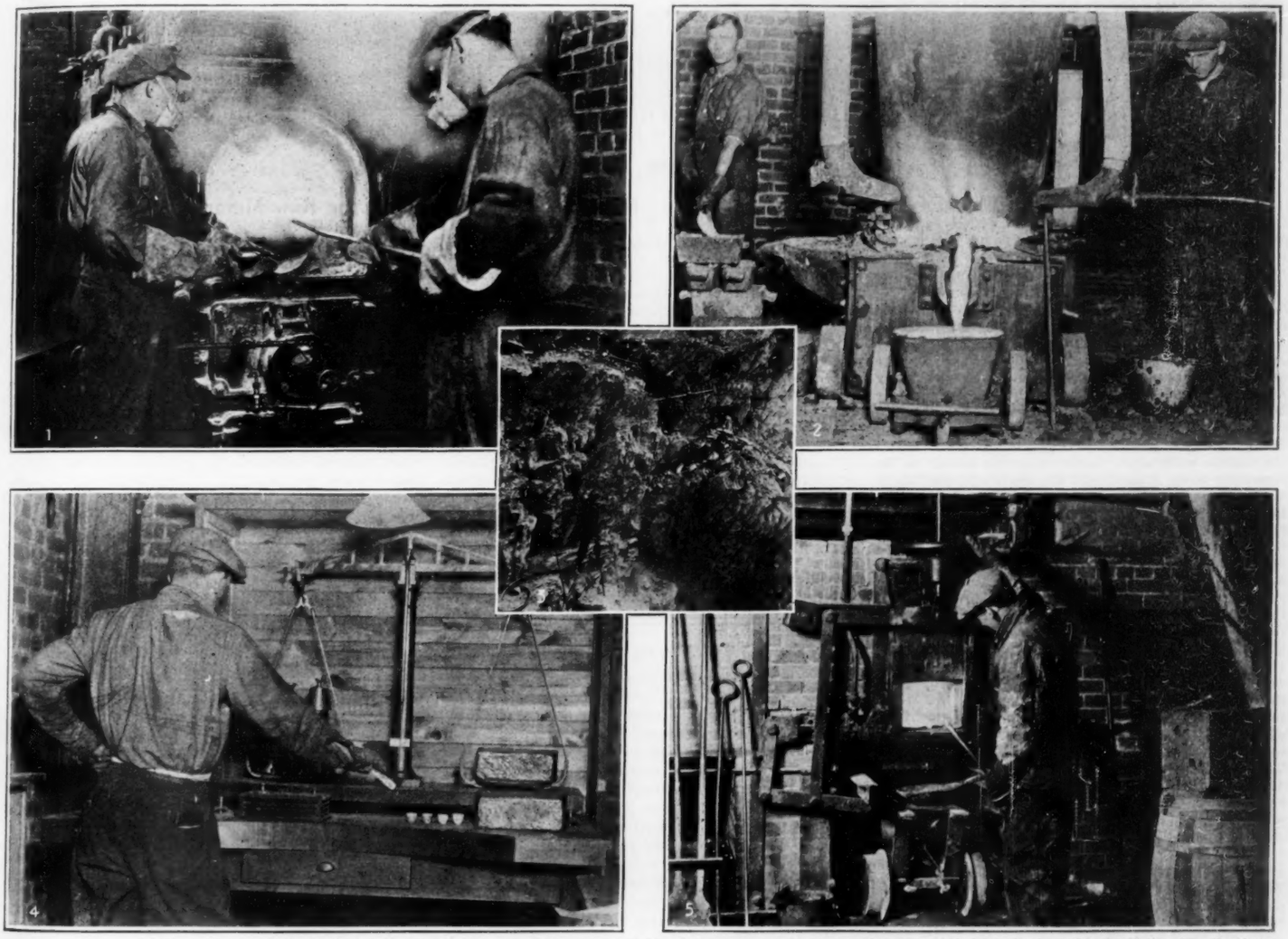
markable that the ore, which costs about the same to mine, per ton, can be afterwards put through the expensive milling and refining process and yield a profit on the operations.

When our mine is operating at full capacity there are approximately one thousand men employed on the property. Of these, a large proportion are of the "Hunkie" type; single men who find quarters in the company's bunk houses. The greater part of the mine officials live in houses built by the company on its own property. This group forms a little hamlet about the mine and has its company operated store and little red brick school house.

It is regrettable that social conditions, as in most small, isolated communities, are somewhat cramped. Educational facilities, too, are practically nil, so that the mining camp does not usually appeal to the family man as an ideal place to live. These conditions do not mean so much to the single man, however. Of course there is a total lack of recreations such as are known to the city dweller, but the fact that certain men do stick to the country year after year is proof enough that there are compensations for those that enjoy the life. Fishing, hunting, tramping and canoeing are ever-available sports, and a prospecting trip two or three times a year fulfills the ambitions of many an old-timer. The fact that they never become discouraged, no matter how poorly their samples may pan out, indicates that it is the life in the open rather than the prospect of a real find, that sends them off on the trail again and again.

It must not be supposed that the labors of these amateur prospectors are always fruitless. Many valuable properties have been and are constantly being discovered in this manner. There are thousands of square miles in Northern Canada that have never been prospected, and there is every reason to believe that there are rich rewards awaiting the enterprising and courageous prospector. A brief study of the map of Canada often proves a great surprise. We are most of us wont to think of our Northern cousin as typified by Toronto, Montreal, or the Prairie Provinces. A glance at the map will show, however, that Canada as a whole is still a great wilderness into which civilization has penetrated only a few hundred miles or less, along her Southern border. Beyond that are vast tracts of land where the trails of man would show only as tiny threads, penetrating the wilderness here and there at long intervals and finally dying out altogether.

To some of us the call comes clear and strong, the call of the North, to make our own tracks in that great wilderness. Our dreams are long beneath its spell. But not all can heed the call. Some must but dream. The chosen few will go.



1. Gas masks are used in the presence of the cloud of mercury vapor that issues from the retort when the latter is opened to remove the sponge gold. 2. Pouring bars of lead-gold alloy from the blast furnace. 3. A driller at work while his helper scales loose rock from the pit wall. 4. The final weighing before shipment to the mint. 5. A tiny stream of molten litharge may be seen dripping into the ladle

Steps in the ultra-modern technique for making the gold ore give up its values

Keeping Growing Potatoes Cool

AN Iowa potato investigator, C. L. Fitch, has determined with exactitude the effect on growing potatoes of varying degrees of heat. Not the potato bug, nor any of the various potato diseases, is the most serious enemy of the potato, Mr. Fitch has found. The greatest enemy of the growing spud is heat. When soil temperature gets just about so high, the potato grower can simply say farewell to a profitable crop. This temperature is a few degrees above 85.

So, "keep your potatoes cool," is exceptionally good advice to the grower. In fact, in all latitudes where spells of very hot weather are of fairly common occurrence, measures to protect the growing spuds against heat should be regularly practiced. Some of these begin at planting-time; others can be adopted in the emergency when it arises.

Deep and constant cultivation is probably the best measure the grower can adopt when abnormal heat begins to bake the soil. Mr. Fitch recommends it. Stirring the earth to a good depth, and doing it often, keeps down the soil temperature.

In the well-fertilized field, potatoes stand heat better than on poor soil. This is because the tops grow to good size, spread out, and shade the ground. The shade keeps the soil temperature down.

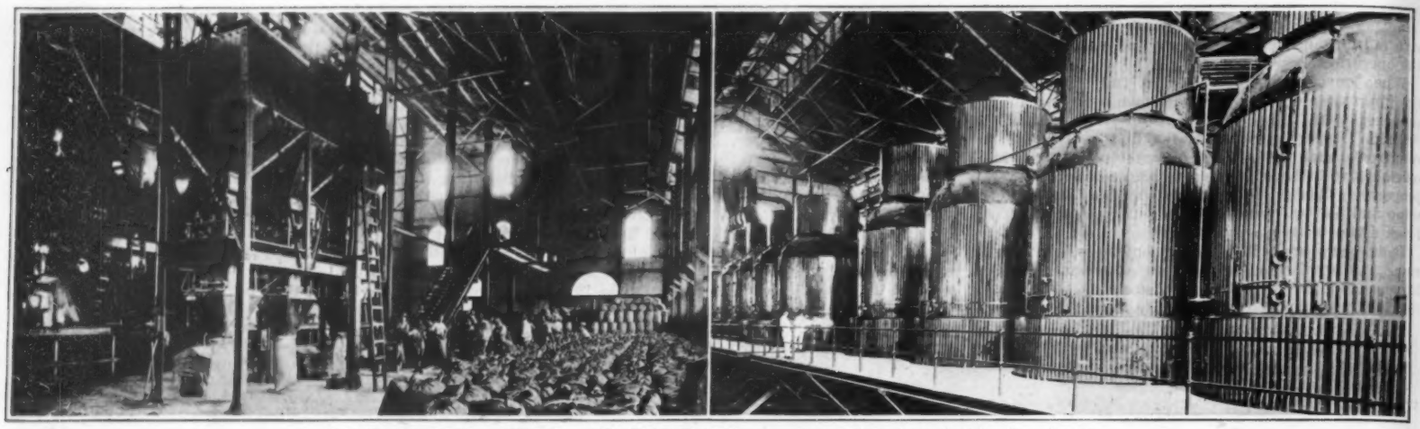
Using seed grown in a cool climate is a precaution. Potatoes from such seed are more resistant to heat than others.

The high temperature of a dry soil is not so harmful to potatoes as the equally high temperature of a waterlogged soil. This means that soaking a potato patch in very hot weather may be very dangerous.

These are the methods to protect potatoes against heat that Mr. Fitch recommends: In localities where heat is a serious annual problem a field with a northern or eastern exposure would be more suitable, if available, than other exposures.

The potato plant, Mr. Fitch has found, flourishes best at a soil temperature of 70 degrees. The seed will sprout and send up shoots at 50 degrees; the plant will get along at 85 degrees of soil heat. A temperature of 90 degrees, however, is about the limit of safety.

Of course, soil temperature and atmospheric temperature are two different things. Soil temperature is much more constant. The tops of the potato plant can stand much greater heat than the roots—it's the roots the grower needs to care for.



Left: Bagging the sugar in a Cuban mill. *Right:* Eight big vacuum pans that extract the juice from the cane

Preparing the raw sugar for shipment to the refinery

The Story of Sugar

Where the World's Supply Comes From, and How It Is Converted from the Raw Material

By Arthur L. Dahl and Rozel Gotthold

THE adjective "sweetest" has long been appropriately applied to sugar, and not so long ago a new word—"dearest"—was crowding it for popularity. Sugar, in one form or another, is one of the most plentiful foods we have, for Nature distills sweetness in a large proportion of her vegetable plants, flowers and trees. The sugar of commerce, however, is obtained principally from two raw materials—the sugar cane and the sugar beet. Only three countries of the world produce both cane and beet sugar: the United States, Australia, and Spain; for cane production is practically restricted to the tropics, while sugar beets are grown mainly in the temperate zone. One-fifth of the world's production of cane sugar comes from Cuba, another fifth from India, and one-tenth from Java. Next in order of importance as producers of sugar, of one sort or the other, are Germany, Austria, Russia (in normal times), the United States, Hawaii, Porto Rico, Formosa, Australia, Peru, and Mauritius. During the war one-third of the world's sugar-producing area lay within the battle lines of Europe. The war has had the effect of largely increasing production in Cuba, Java and India, but Porto Rico, Hawaii, the Philippines and British West Indies show little increase, although all of these countries have been important sugar-producing districts for a long time. In 1910 the world's production of cane and beet was equal. Now the ratio is about 70 per cent cane to 30 per cent beet. In Europe the production of France has been reduced to a fraction of its pre-war size, and Belgium and the Central Powers are producing about half as much as formerly.

The United States is not the greatest consumer of sugar per capita, that distinction going to Australia, with an individual consumption of over 100 pounds per annum; but at the rate we are increasing our consumption we shall soon outstrip Australia. In 1919 we used over four million tons of sugar in the United States, or 16 per cent more than the year previous. This amounted to over 92 pounds per capita, as against 85 pounds in 1913, 84 pounds in 1914, 79 in 1917 and 73 pounds in 1918.

The United States is dependent upon outside sources for over three-fourths of its sugar supply. While cane sugar is grown in a small area in the extreme southern part of our country, principally Louisiana, our domestic supply of cane sugar represents less than 4 per cent of our consumption, and would last us but 14 days each year. From our domestic crop of sugar beets we obtain a larger quantity of sugar, and the supply from this source would fill our wants for 78 days out of a year. Cuba supplies us with more sugar than any other country, sending us almost 51 per cent of our consumption. We secure almost 13 per cent from Hawaii, 7 per cent from Porto Rico, not quite 2 per cent from the Philippines, and a little over 2 per cent from outside miscellaneous sources. The following table shows the source of the sugar used in the United States in 1919:

United States beet	872,253 tons
Louisiana and Texas cane	154,034 tons
Hawaii cane	514,824 tons
St. Croix cane	8,286 tons
Porto Rico cane	286,880 tons
Philippine cane	72,511 tons
Cuba cane	2,067,051 tons
Maple sugar and molasses	34,094 tons
Miscellaneous foreign	57,738 tons
Total	4,067,671 tons

SUGAR, with its meteoric rise in price and its cataclysmic descent, has been a household word these four years past. Our bewilderment over the causes of 25-cent sugar and the impossibility of getting a supply at this or any other price was equaled only by our puzzlement when the bottom fell out of the market and we could suddenly have all we wanted of the universal sweetener. Many of the contributors to the Scientific American were moved, at one time or another during this period, to attempt the telling of the story of sugar. Mr. Gotthold and Mr. Dahl were the most successful of these. We have refrained from publishing what they or anybody else had to say of sugar until the lapse of time had given sufficient perspective to insure that nothing would creep into our columns that might later appear unjust or inspired by the abnormal conditions. Now that the time is ripe to tell the story of sugar, we have decided to make this story even more conspicuously noteworthy by weaving the best elements of these two contributions into a single narrative; the one presented here.—THE EDITOR.

The oldest source of our domestic sugar is a section of Louisiana east of the Mississippi River and extending to the Gulf coast; and thereby hangs a tale. In 1776, the cultivation of sugar cane was actually given up in Louisiana, as unsuited to the climate. But in 1795, Etienne de Boré made a crop of sugar which netted him $12,000, a large sum of money in those days. Until 1794 he was a planter of indigo, which was the important crop of the period in Louisiana. But the losses from hurricanes and the ravages of insects were tremendous, so that Boré looked about him for something else to plant. There were two Spaniards in New Orleans planting considerable cane, but they had never got sugar from it; one of them boiled the juice into syrup, and the other distilled it into a poor quality of liquor. Boré bought some canes from these men, which later gave him his fortune.

It is interesting to read of the sugar-making in Gayarré's History of Louisiana: "On the day when the grinding of the cane was to begin, a large number of the most respectable inhabitants had gathered in and about the sugar-house to be present at the failure or success of the experiment. Would the syrup granulate? Would it be converted into sugar? The crowd waited with eager impatience for the moment when the man who watches the treatment of the juice determines whether it is ready to granulate. When that moment arrived, the stillness of death came among them, each one holding his breath, and feeling that it was a matter of ruin or prosperity for them all. Suddenly the sugar-maker cried out with exultation: 'It granulates!' and the crowd repeated, 'It granulates!'"

Outside of this Louisiana region cane is grown generally throughout the Gulf States, but there it is used almost exclusively to make syrup and not sugar. Practically the only other cane sugar from our Southern States is made in a few scattered localities in Texas. Sugar cane requires a long growing season to mature fully, and the prevalence of frosts in most sections of the country precludes the extension of the growing areas beyond the present limits, except possibly in Florida, where successful plantations have been made.

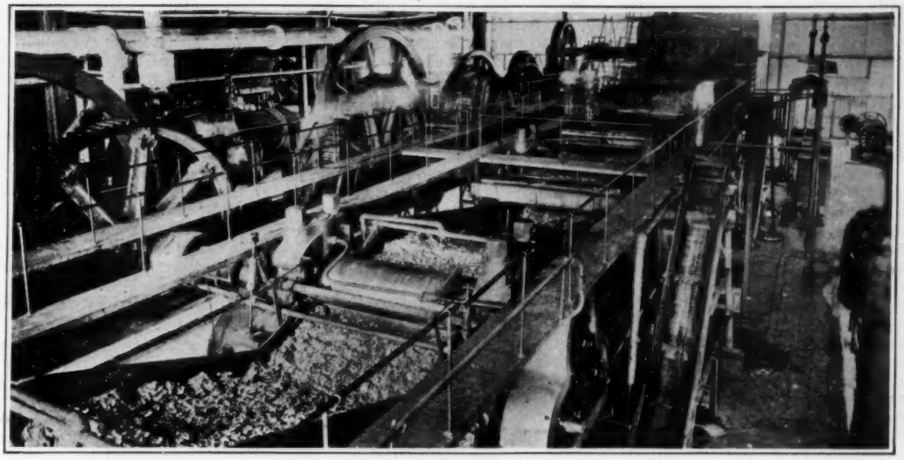
The center of the cane industry in the South is in the parishes of St. Mary, Lafourche and Terrebonne, in Louisiana, where cane occupies 42 per cent of the improved land. These three parishes, in fact, grow about 40 per cent of the total crop of sugar in the South. They also contain 51 of the State's 150 operating factories for the crushing of cane. One of the characteristics of the Louisiana sugar industry is its uncertainty. Cane does not mature there, for the growing season is too short. Cane is harvested before it is fully ripe and the cutting season is limited to the several weeks between the middle part of October and the coming of the winter frosts. Working immature cane results in a lighter tonnage per acre than is obtained in Cuba or other tropical countries, where the cane is allowed to grow from 12 to 18 months, and it also results in a smaller sugar content in Louisiana than in the tropics. As an evidence of the fluctuation of the cane production in Louisiana, due to climatic conditions, we find that in 1904 the State produced a record quantity of 398,195 tons, while in 1919 the total production of cane in Louisiana and Texas combined was only 154,034 tons. The difference is wholly due to unseasonable weather.

Of our island possessions, Hawaii is the greatest source of our sugar supply. The principal industry in the Hawaiian Islands is the growing of sugar cane and the manufacture of raw sugar. It has the most highly developed organization for sugar production found anywhere, and about one-fourth of the entire population of the islands is engaged in this industry. There are some 50 mills, practically all of which are large or medium sized, the annual production of a mill ranging from about 4 million to 100 million pounds. The season in Hawaii is long, beginning nominally about October 1st and continuing for a large part of the following 12 months. Nearly all of the crop consists of raw sugar which is shipped for refining to San Francisco and to Atlantic refineries. There are about 250,000 acres devoted to growing cane in the Hawaiian Islands, and owing to the long growing season only about half of the growing acreage is cut each year. In the same field

one can see planting and harvesting operations going on side by side, as the land is prepared for a new crop just as soon as the mature cane is removed. The yield of cane is heavy in these islands, ranging from 39 tons per acre to 46 tons in a good year, and the cane is high in sugar content, yielding an average of 245 pounds of sugar per ton of cane.

Nearly all cane is grown under irrigation in Hawaii, and in the development of the water resources of the islands the sugar planters have earned the reputation of being the most daring and successful land reclaimers in the world. The rainfall in the islands varies to a marked degree in areas not far apart, owing to wind conditions and the location of high mountains. In some sections the rainfall is too excessive to permit of cultivation, while in others it is deficient. The sugar planters, therefore, have constructed immense irrigating reservoirs and canals, often taking the water from one side of a mountain and conveying it through miles of tunnels to where it is needed. Two of the oldest plantations, Koloa and Lehue, have jointly over 40 miles of tunnels which tap the mountain streams. They also have a system of 9 storage reservoirs with a capacity of over 75 million gallons every 24 hours. Twenty-four plantations in the Hawaiian Islands have an investment of over $13,000,000 in reservoirs, pumping stations and equipment, pipe lines, ditches and irrigating flumes, and 14 of the sugar companies own 97,000 acres of forest land, maintained solely for the development of water. The Oahu plantation with a cane acreage of only 8559 acres, has spent almost $3,000,000 in the construction of the great Waiahoii Aqueduct, which required more than three years to build. This aqueduct is 14 miles in length and includes 10 miles of tunnel, 3¼ miles of concrete-lined ditches, and 1⅛ miles of steel syphon pipes. The main tunnel is 14,443 feet in length, piercing the Koolau mountain range. The mills for crushing the sugar cane in Hawaii are the most modern in the world, and machinery is used wherever possible. While considerable fuel is required to operate the crushing plants, practically all of this is secured from the refuse, or bagasse, left after pressing out the juice from the cane.

Sugar has been the principal crop grown in Cuba since its early days, and over half of the cultivated area of the country is devoted to cane. Climatic and soil conditions are favorable for its growth, and the cane is allowed to stand for 12 to 18 months before cutting. It is only necessary to replant the cane fields every 4 to 7 years in the older sugar districts and from 10 to 12 years in the new ones, as most of the production is from "ratoon" crops which spring up from the root systems and stalks left in the ground after harvesting the mature cane. A higher production is obtained from what is called the "plant cane crop," but on account of the saving of labor, the ratoon system is largely in vogue. The cane crop is harvested more or less throughout the year, but the principal harvest season is from December to June. Over a million and a third acres are devoted to cane production in Cuba, and there are 175 factories in operation, grinding the annual production of 15 million tons or more of cane. The sugar plantations are equipped with private railway lines to transport the cane to the factory, and altogether there are over 2802 miles of such roads, using 15,161 cars and 485 locomotives. The daily grinding capacity of all the factories is about 240,000 tons of cane, and the sugar content of the cane averages from 11 to 15 per cent of the weight of the cane.



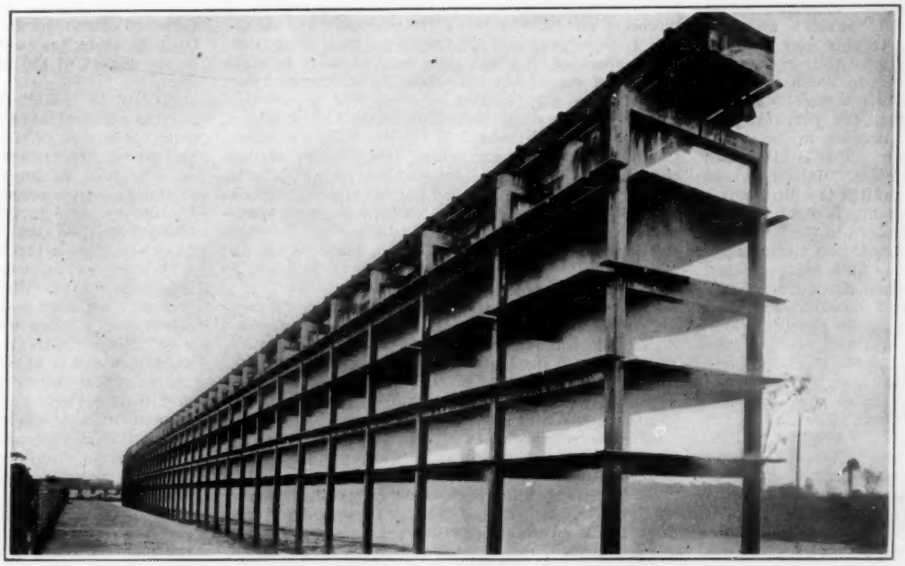
36 x 84-inch roller mill with fifteen rollers, and 36 x 87 double crusher, all driven by three engines

The sugar factories of Cuba have made considerable improvement in the use of modern equipment during the last few years, and the United States manufactures and installs most of this machinery. One factory in St. Louis is said to supply a large proportion of the sugar-making machinery used in the cane districts of Cuba and Porto Rico, and American machinery is fast supplanting the primitive and inefficient methods used in the earlier grinding mills.

Porto Rico is also an important producer of sugar cane, and there are 65 establishments for making sugar. In normal times Porto Rico supplied the United States with something over 700 million pounds of raw sugar per annum, but during the war her production was greatly stimulated and her annual crop now exceeds a billion pounds, practically all of which comes to this country. There are 203,000 acres of land devoted to the growing of sugar cane. Some of the large grinding mills, or "Centrals" have a capacity of over 40 million pounds of raw sugar each season, and United States manufacturers build most of the modern machinery for the sugar mills.

While sugar is classed as one of the leading industries of the Philippines, with an annual production up to a billion pounds, only a part of the raw sugar is sent to the United States, as nearer markets lie in China and Japan. The methods of handling sugar in the islands are still somewhat primitive and most of the cane is handled in small mills operated by the natives.

The British West Indies hold third place in sugar production from British possessions. The island of Trinidad is the center of the cane industry, and in some of the adjoining islands much of the cane is used for the manufacture of "fancy molasses" which is largely sold in Europe.



A big cooling tower in one of the Cuban mills

Sugar cane is also grown, more or less extensively, in Mexico, Costa Rica, British Honduras, Argentina, Brazil and the other countries of Central and South America, where climatic conditions are favorable. India grows an enormous quantity of sugar cane, but practically all of it is needed to feed the millions of people within its own boundaries. Australia and New Zealand also grow sugar cane, but the production is not sufficient for domestic needs and little of it is exported. The Island of Java, in the Dutch East Indies, devotes 405,000 acres to the growing of sugar, and a high yield is obtained from the cane grown there, being exceeded in sugar content only by Hawaii. A large part of the Java production is exported, but little comes to the United States except in times of great scarcity, or when prices are high. We got a good deal of Java sugar in 1919 and early 1920. One shipload of East Indies sugar arrived in San Francisco for the use of fruit canners, who had found it cheaper to purchase this oriental supply than pay the prevailing prices in the United States.

The method of handling cane is very much the same in all countries. When mature, the cane is cut by hand and conveyed to the crusher by railroad, flume, or ox cart. The modern sugar mills are equipped with a series of iron rollers through which the cane passes, and the juice is squeezed out and conveyed to tanks while the dry pulp passes on and is used for fuel. The cane juice, in addition to the sugar in solution, contains glucose, other non-crystallizing sugars, fats, waxes, gums, nitrogenous substances and a small amount of acid. In the mill the juice is boiled in vacuum tanks to extract the 74 per cent of water it contains, and the remaining substances are treated in different ways to separate the various constituents, until finally a crystallized raw sugar is obtained, which is put up into sacks and sent to this country or to England for refining.

This sounds simple enough; but sugar-making today is not so elementary a matter as it was for Boré. He and his friends would have a real thrill if they were to be taken into a sugar factory, to see the crushers and mills, the filtering, the evaporation, the crystallization of sugar, in those interesting machines.

The mills used are three 3-roller mills, set tandem. They are driven by one engine, and are geared at one side. Each mill has a headstock, of solid heavy casting, bolted through to the lower plate by two king bolts. There is a top roller, with two others underneath it. In the center of each mill is a trash-turner which sends the bagasse, or partially crushed cane, from the top to the last roller of the mill. The rollers are grooved, and experiments are constantly being carried forward to deepen the grooves, the newest rollers having grooved surfaces to the depth of three-quarters of an inch, which facilitates the crushing. The cane is prepared for the mill by crushers; the type most in use is composed of two rollers, having surfaces with great V-shaped grooves. The rollers may be set either to crush the cane or to cut it into small pieces. From the mill, the juice rolls down into the trough underneath it, and thence to a tank, for sulfuring. The bagasse is sent to the bagasse burners, for fuel.

In the making of direct consumption sugars, the juice is treated by using sulfur dioxide, which bleaches it, and lime, which settles it. At the Audubon Park Experiment Station, conducted by the Louisiana State University, there has been carried

out a very interesting experiment in clarification of cane juice with diatomaceous earth and decolorizing carbon. The diatomaceous earth used is found in quantity in California. It has been used for filtration purposes in the best sugar factories of Europe since 1886. A ton of it, with freight charges, from California, costs in Louisiana about thirty-five dollars. The vegetable carbon used for decolorizing the juice comes from Holland, and that is about all that is known of it here.

For this experiment the juice from the mill, instead of being sulfured, was put into the clarifier, where it was treated with one-half per cent of filtering earth, then the entire contents were run through the filter-press, into the second clarifier, and then treated with one per cent of the decolorizer. The result of this method of clarifying was that they got at least as much sugar as the yield by sulfitation; that the raw sugar obtained has the color of yellow clarified without washing in the centrifugal; that it contains less non-sugars than that obtained by the sulfitation process; that the expense attached to its use will in all likelihood be considerably lessened by the sale of the improved grade of molasses which results, and which is expected to sell on the New Orleans Exchange for 65 cents per gallon—an excellent price.

To appreciate the importance of this new clarification, one must understand the system which has heretofore been used. The sulfured juice is sent to the clarifier, where it is brought to the boiling point. This causes the heavier particles of dirt to fall to the bottom, the lighter scum to rise to the surface of the liquid. Between the two is the layer of clear juice. The bottom of the clarifier is opened, the mud falling into the mud tank. When the juice comes clear, the clarifier is closed, and the juice is run off into the settling tanks. When the layer of aerated scums begins to be drawn off, the valve is closed, and the scums are run off through the filter-press. All of this part of sugar-making, therefore, is eliminated by the new process, which saves a great amount of time and labor, as is to be seen: the entire contents of the clarifier, containing juice and filter, being run through the filter press at once; treated with decolorizer, and run through again. For in the actual filtering, the filtering agent, which is composed of particles of silica, rapidly takes on the particles of scum to form a cake, which particles, without such aid, would have clogged up the cloth of the filter bags, making the process of filtering slower and more tedious because of frequent changing of the bags.

The filter-press used is a frame-and-plate press, composed of hollow frame and solid plate, placed alternately in the press. Each of these has two openings in it, in the angles, which form two channels running through the press. Each, also, has a cock, to let the clear juice out. The bags are placed over the solid plates, and the scums forced through the press in such a way that the cake is formed of them between the bags, when the juices are pressed out. Then water is forced through the cake to wash it of the remaining sugar.

The cake contains 69.72 water, some sugar, glucose, wax, albumen, fiber, organic acids, gums, sand, clay. It is used for fertilizer.

The juice is next sent to the evaporators, where it is boiled into syrup. A considerable difference exists between the intricate system of "effects" and the earliest method of evaporation, in pots over an open fire. The latest word is a triple-effect evaporator, equipped with special interceptor to catch splashing sugar bubbles and return them to the vessel. Instead of a horizontal system of tubing, the evaporator is equipped with vertical tubes, attached to two tube plates, forming a steam chamber. This is filled with steam all around and above the tubes. Juice is turned into the vessels from the tank, until it is a little above the tube system. The vacuum pump is started, and a vacuum of twenty-five inches obtained in the last effect. The water injection cock is opened, and steam is admitted to the first evaporator. This begins to boil the juice, and the vapor rises and flows through the vapor pipe into the second body of the effect, which has already been filled with juice a little above the tube system. The tubes condense the vapor, and the juice boils. This process is repeated in the third body, etc.

The juice leaves the effect in the form of thick syrup. It is drawn upward into the vacuum pans, in which occurs the real art of sugar-making. The vacuum pan has virtually the same form as the effects. Instead of the steam chamber, however, it is fitted with a system of steam coils, each having its valve. A vacuum is obtained as before, and the syrup is distributed evenly through the pan. The idea is first to grain the sugar, and here the man at the post takes samples of the syrup by pulling out a wooden plug at the side of the pan, having grooves in which he obtains a small amount of sugar. He tests this and when the grain is obtained, he feeds the pan with fresh charges of syrup in order to make the sugar crystals which now begin to separate and fasten on to the grain already formed. If a new crop of grain is made, it is called "false grain or dust," and is not wanted, as it will be lost in the centrifugal. But to get an even crystallization, the pan must be evenly boiled, and the temperature must not be changed.

If a large-grain sugar is required, a small quantity of syrup is granulated at a time. This is called "graining low down." If a small-crystal sugar is wanted, large charges of syrup are put into the pan. This is called "graining high up."

How long to boil a pan, in order to "make a strike," is a matter of the purity of the juice, the size of the pan, etc. With very pure juice, boiling may be continued four or five times. With impure juices, two sugars are as much as may be obtained.

The contents of the vacuum pan, called "masse-cuite" consist of sugar and molasses. They are taken to the centrifugal, which is a perforated basket, cylindrical in shape, having a strainer of fine wire gauze. The centrifugal is made to revolve at a high speed, throwing the masse-cuite violently against it. The strainer retains the crystals, the molasses passing through it into a space outside of the strainer, whence it flows along a gutter into tanks. The first molasses is boiled back, and as said before, if the juice is very pure, three and four sugars may be obtained. The sugar in the centrifugal must be washed, when white sugar is required, then dried under high-pressure steam.

Sometimes, on the plantation, crystallizers are used, when a large quantity of small grain sugars may be made of juices not so pure. These vessels are fitted with paddles which stir the masse-cuite constantly, cooling it, thus crystallizing it.

There are 22 cane sugar refineries in the United States with an estimated maximum capacity of daily meltings of 40 million pounds. In these refineries the raw sugars from Hawaii, Cuba and other countries are refined and made into the granulated and cube sugars of commerce. The by-products of the refineries are made into molasses for human consumption or into stock food.

Contrary to popular belief there is no chemical difference between refined sugar made from cane and beets. The grains made from cane raws may be slightly finer in texture than the beet sugar, but one is just as sweet and good as the other. This is true of the beet sugar made in the United States, though the beet factories of Europe have not yet succeeded in turning out as fine a grade of refined sugar from beets as we have, and much of the prejudice against beet sugar is caused by the appearance of the imported article.

If the United States had to supply all her own sugar, she could do it only by increasing the area planted to sugar beets, and it is entirely feasible to enlarge greatly our production from this source. In 1919, there were 692,455 acres of land devoted to the growing of sugar beets in the United States, and we produced 726,451 tons of refined sugar from this acreage. Although this was the largest area sown to beets in our history, the production was disappointing, due to adverse climatic and other conditions. Not only was the production of beets per acre lower than normal, but the sugar content of the beets was likewise below the average. At that the beet growers were paid $75,420,000 for their crop. Generally speaking, it takes eight tons of beets to make one ton of sugar; but the refuse, in the form of beet tops and beet pulp, is used for stock feed or fertilizer.

There are 99 sugar beet mills in the United States, most of which are located in the States of California, Colorado and Michigan, which three States produce three-fourths of our total crop of beet sugar. The industry, however, has assumed important proportions in some of the Lake States, such as Illinois, Iowa, Minnesota, New York, Ohio and Wisconsin, and in the Northwest, including Washington, Oregon, Idaho, Utah, and Montana. Both cane and beet sugar is produced in Arizona, though not in large quantities.

The season for harvesting beets and making sugar begins in California late in July or early in August, and Utah, Colorado and States farther east late in September or early in October. The sugar campaign is usually over by January, but may continue until March. The beets are sometimes kept until time for slicing by siloing them, which means that they are put in piles with sufficient earth thrown over them to protect them from frost. The average production of sugar beets per acre is around 9 or 10 tons, and the growers are paid by weight, with a sliding scale based on the sugar content of the beets. In 1919 the average price paid for sugar beets to the growers was $11.75 per ton, as against $10 per ton in 1918.

The process for making sugar from beets is entirely different from that of cane, except in the later stages. In cane the juice is extracted by crushing, while with sugar beets the sugar juices are extracted by what is called the "diffusion process." In the beet sugar factory the beets are washed, sliced and placed in the diffusing cells, where the sugar is extracted by a complicated chemical process, and then passes to the saturating, sulfuring, evaporation, concentration and curing departments. The equipment for beet sugar making is elaborate and costly, it being considered that a plant costs approximately $1000 for each ton of beets processed, so that a plant to handle 1000 tons of beets would cost a million dollars. As a rule, sugar beets are grown under a community arrangement to insure an adequate supply for the mill.

The Self-Supporting College

A TECHNICAL school which will be self-supporting, with a student body also self-supporting, is the promise of a plan for reorganizing Antioch College fostered by Arthur E. Morgan, widely known engineer. Mr. Morgan is just bringing to completion for the City of Dayton a $50,000,000 flood prevention project, the greatest of its kind, and is soon to undertake a similar scheme for Pueblo, Col. He has become President of Antioch College, near Dayton, and will direct his industrial enterprises from there.

Associated with Mr. Morgan in his unusual educational undertaking are a number of engineers, bankers, lawyers, farmers and manufacturers, some of national and all of at least local prominence. These even form the Board of Trustees and they have largely furnished the money to launch the enterprise, with the expectation that it will be independent of endowment within a few years.

Following the example of Mr. Morgan, both faculty and students are expected to engage in actual commercial enterprises, part of the proceeds of which will go to the college. It is the plan to engage as instructors the best men in their respective fields. A small college ordinarily could not afford to pay the salaries of these men. But under the Antioch plan they will get a salary of slightly less than they have received in the commercial field. Each department head will be expected to work up a consulting business. In this he will be financed by the school and his plant and equipment furnished. As far as possible his assistants and students will constitute his working force. Half of the proceeds of such enterprise he will retain and half will go to the college.

Most of the students will spend alternate periods of five weeks at school and in a nearby commercial institution, where they will be employed along the lines of their studies. There is now being erected on the college campus a commercial machine shop, where small articles will be manufactured and repair work done. This will be conducted as a commercial venture by students, who will be responsible for profit or loss. A dairy farm soon will be opened under the same plan. Other industries will be added later, including a publishing plant.

"Education has always been a hobby of mine," said Mr. Morgan, in a recent interview with the writer, "and I determined that if ever the opportunity came I would try to fill what seems to me to be a big need. The average college graduate either has acquired a classical education with no preparation for entering business, or he has become a highly trained technician, to the neglect of the broadening influences of general study.

"It will be the aim of this institution to turn out, not the classical scholar or the highly trained technician, but a man or a woman who is enough of each, and who at the same time has enough practical experience to take up an independent place in life. We intend to help a student, through our courses, to find his proper place in life and to give him or her the broad foundation that every person ought to have before he or she takes a highly specialized technical course.

"We expect to derive from our plan two highly important results. First, by being free from the necessity of constantly seeking endowment, we make ourselves free to work out our own destiny in our own way. The man who gives money to a college, you know, usually wants to know how it is to be spent. We do not want any strings tied to us. Secondly, we will be able to hire big men, and one of the finest things we have to offer is the intimate contact of the student body with the personalities.

"We intend always to remain a small college, for the reason that such personal relations are not possible in a large institution. If our plan is successful, that will only give us a chance to pick our students more carefully. We want a student body and a faculty with the pioneering spirit, for we are cutting a new path in American education."

Anatomical Artistry

GUSTAVE VAN BOUCHAUTE, a quaint Belgian, holds an unusual position in the artistic world. At one time a plasterer and sculptor, he has turned his art into a useful channel. He is employed at Bellevue Hospital, N. Y., where he models all parts of the human anatomy and paints them in exact colors for students who are learning medicine and surgery. His models, say the authorities, will soon be used all over the world as they are now in New York hospitals and eastern Universities. The models, which are of stucco, are made in the following manner. A plaster cast of the organ is made after it has been well smeared with formalin. Into this mold is placed a composition of plaster, cloth and glue which is light and easy to work. When this composition is taken out of the mold it must be painted the exact color of the human gland, bone or muscle it represents. The molds are as accurate as the body itself.

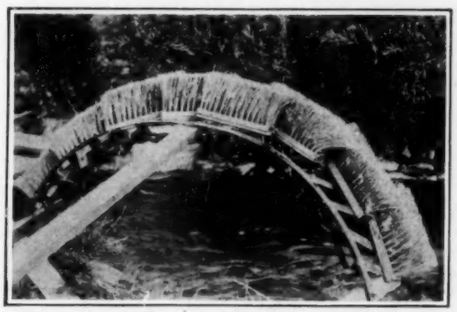
Making anatomical models with plaster and brush

Moss Scrubber for Irrigation Projects

SPEEDING the flow of water in the irrigation projects of the West is promised through the use of a scrubber for cleaning semicircular flumes, a device recently designed and perfected by Charles B. Schmidt, manager of the Selah-Moxee irrigation district, in the Yakima Valley, Washington. The moss and silt that accumulate on the interior of the flumes are removed by this tireless mechanical arrangement.

A series of stout-bristled scrub brushes is fashioned in a semi-circle to the base end of a triangular frame which is supported at the apex by a small wheel. The scrubber is placed in the flume at the head end, with the brushes "rubbing elbows" with the sides of the conduit. The wheel, at the front end of the frame, rests on the floor of the flume. The velocity of the water is of sufficient progressive action to keep the scrubber in motion while the wheel guides and keeps the device from wedging. A heavy iron chain secures the tireless worker in place and forces the brushes against the sides of the flume.

The cleaning operation may be repeated if a single application of the scrubber does not suffice. Of course, the swiftness of the stream in many of the projects is such as to discourage the growth of moss and the accumulation of silt. However, when the current is tempered in its rate of progress this novel device is an efficient agent for the cleaning of conduit.—*By S. R. Winters.*



This curious collection of brushes scrubs the moss off the banks and bottom of the ditch

How More Light Speeds Up Vision

THE talking machine has found a new use! Did you ever try to read the name of a record, as the record went around and around on the machine? Of course you have—and you probably could have done it successfully if there had been plenty of light.

Some able illuminating engineers not so long ago decided to construct a simple apparatus by which they could demonstrate to anyone the fact that good light enables the eye to see faster.

A cylinder in diameter the size of a phonograph record and about 15 inches high was built, and on the surface of this roll or cylinder, letters and figures of various sizes were pasted. These letters were placed in no particular order and when they had finished the whole thing looked much like an optician's chart, only cylindrical in shape instead of flat.

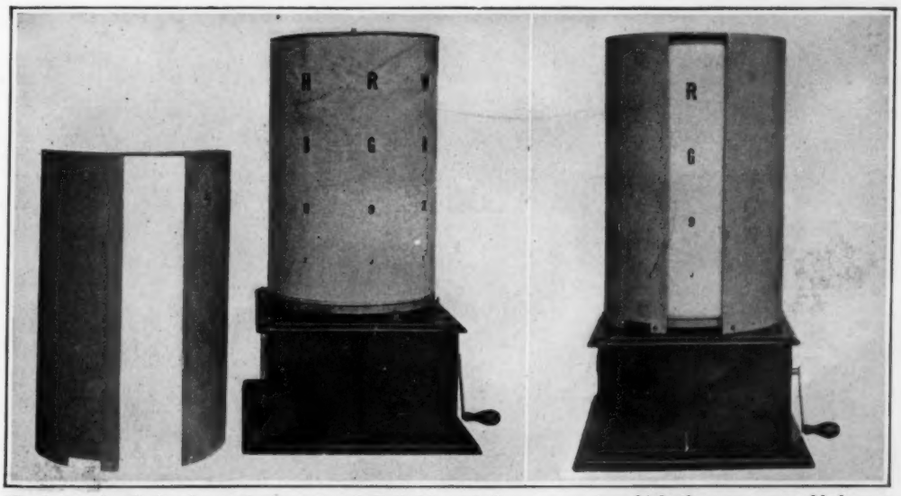
The lettered cylinder was then put on a phonograph and when the machine was started the cylinder of course revolved. To cover the front of this another hollow halfcylinder was made but this one had a slot about 2 inches wide along its entire length. When the half cylinder was placed over the revolving one only that part of the moving surface directly behind the slit was visible.

Thus, different letters of alphabet and figures, etc., moved past the opening and it was the duty of those observing the apparatus to find out which letters they could read; in other words at the speed at which the machine was then moving to find out which was the smallest size of figures or letters that could be recognized.

During the first experiment the lighting of the room was that ordinarily found in the workshop or office, perhaps four or five units. After all were satisfied that none of the smaller letters or figures could be distinguished additional light was thrown on, sufficient lamps being used to raise the intensity of the light from four units to over twenty units.

To the surprise of each observer the smaller undistinguishable revolving figures immediately took definite recognizable shape, while the speed of the machine actually *seemed* to slow down. Of course there was no change in speed since nothing on the machine was touched; the only change was the increase in illumination.

The human eye is perhaps the most delicate and precious gift that man has, and yet people, day after day, year by year, constantly impair its efficiency by making it work under conditions that are not of the best. If, as the demonstration showed, the eye can see more quickly under light of high intensity, is it not reasonable to suppose that the eye can do a certain amount of work with much more ease when the work is properly illuminated? Make sure that you have sufficient light, whether you are using a machine in the factory or reading a magazine at home.—*By Freeman Barnes.*



The lettered cylinder (center), the outer shell (left), and the manner in which they are assembled on a rotating base to test the bearing of increased illumination upon rapidity of vision

Muscle

IN the *British Journal of Physiology* for August, 1921, Dr. D. Adrian, of Trinity College, Cambridge, presents in a paper of some length the results of investigations on *the recovery process of excitable tissues.* The chief conclusions which Dr. Adrian reaches are that in the frog's medullated nerve the absolute refractory period does not come to an end until the electric response has almost subsided. The gradual return of excitability takes place after the tissue has regained its normal potential. This holds good over a wide range of temperature. In the sartorius muscle the return of excitability comes on much more rapidly. At room temperature the absolute refractory period corresponds to the rising phase of the electric response and the relative refractory period to its decline. At low temperature this relation is disturbed and the return of excitability takes place more slowly than the decline of the electric response. In cardiac muscle at room temperature the return of excitability does not begin until just before or just after the complete disappearance of the electric response and there is evidence to show that in abnormal conditions it may be still further delayed. Incidentally the monophasic electrocardiogram shows no signs of being made up of two components. An initial spike is observed only when the response has become diphasic. The supernormal phase of recovery which takes place in a tissue perfused with an acid solution is not associated with any prolongation of the electric response, either as a positive or negative after-effect. An electric response set up during the supernormal phase of recovery in the heart is no greater than the normal although the accompanying contraction is increased. Thus the return of excitability does not necessarily occur at the same time as the decline of the electric response. The relation between the two processes varies from one tissue to another, and in connection with any given muscle from one temperature to another. There is often no difference of potential between a surface which is recovering from the results of excitation and one which is at rest.

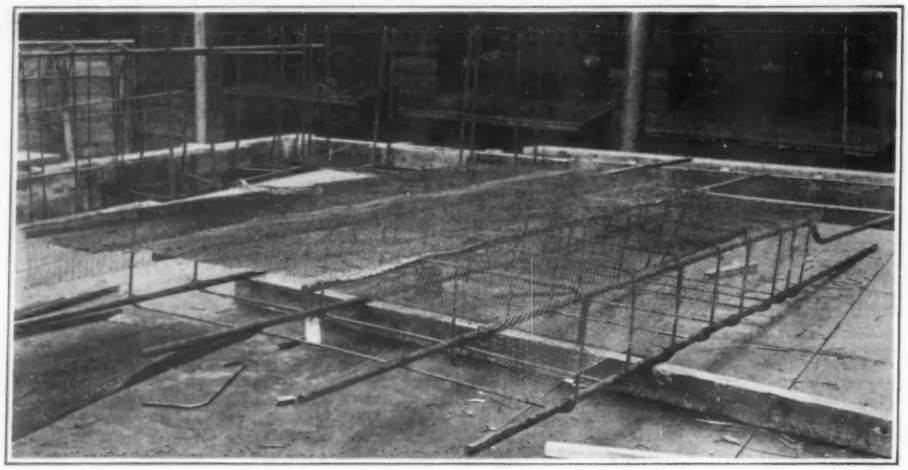
These results, it is important to note, can be explained satisfactorily on the membrane theory by means of the scheme put forward by Lillie. According to this scheme the decline of the electric response is caused by a reduction in the permeability of the surface membrane and the return of excitability is due to a return of the membrane from a stable to a more unstable condition. It now appears more than ever probable that this is correct.

A Climax in Concrete Construction

Erecting An Eighteen Story Reinforced Concrete Building at a Lower Cost Than a Structural Steel Type

By Robert G. Skerrett

THERE is a section of Manhattan Island near the western end of Brooklyn Bridge which is popularly known as the "Swamp." At this point the overburden is made up of strata of fine and coarse sand underlying layers of muck and peat, and this alluvial deposit covers the buried rock to a depth of 100 feet. This ground naturally presents somewhat of a problem in erecting and supporting in a satisfactory fashion a modern towering business structure. And yet despite the physical condition there has been recently reared within this area a massive 18-story reinforced concrete building.



Expanded metal wired to fabricated steel reinforcement, preparatory to setting the metal work in a vertical position for the casting of the concrete side-walls

This skyscraper is the tallest edifice of its kind in existence, and in its construction a number of novel methods were employed both to expedite execution and to insure the strength and stability required to meet the special service for which the building was designed. To be exact, the structure is in the heart of the hide and leather district of New York City, and is intended to answer conjointly for loft and office purposes. From the very nature of the goods to be accommodated it was necessary that the floor should be sturdy enough to sustain unit loads up to 200 pounds per square foot. And let it be remarked here that the cost of the undertaking was less than that of a structural steel building capable of carrying equally heavy floor-loads.

Having elected to use reinforced concrete throughout, it was at first believed that an acceptable foundation could be provided by utilizing rather long concrete piles. The plot measures 70 feet by 80 feet, the edifice is 225 feet high above street level, and from the start it was recognized that the columns would have to bear individual burdens up to 600 tons. This meant exceptional concentration of weight. After further consideration it became evident that suitable concrete piles would necessitate foundations of such size as to involve prohibitive expense for excavation, concrete, sheathing, pumping, and the proper underpinning of a large adjacent building. How, then, was support to be provided which would safeguard against settlement if the foundation were to stop short of the underlying ledge? The puzzle was solved by the adoption of what are termed "pretest piles."

These consist of successively assembled sections of thin sheet steel tubing, 3 feet long and 20 inches in diameter, filled with concrete—the latter, when solidified, carrying the subsequently applied load. The first 3-foot sections of empty steel cylinders were driven into the earth by means of hand hammers. The soil within the short tubes was then excavated by spades and spoons, after which the metal shells were charged with concrete. The pretest piles or concrete columns were located, after the manner indicated in one of the following illustrations, in pits dug beneath the basement floor. The next step, when the plastic material had hardened, was to transfer to the pretest piles, one by one, the cumulative burden of the superposed structure, which by then included the nearly completed first story of the building.

Temporarily, wooden beams or shores were set upon the tops of the concrete-filled cylinders, and these shores were long enough to engage the underside of the wall girders of the exterior columns and similarly to effect contact between the pretest piles and the continuous footings of the interior columns of the edifice. At that stage the bearing value of these novel piles was estimated to be ample to furnish a preliminary support of at least 70 tons of weight per column. Thus, with a minimum of excavation, all was made right for the beginning of the superstructure within a period of only three weeks.

Five or six days later the mass of the superstructure had become such as to permit subjecting a few of the piles to a load test, through reaction, of 40 tons apiece. One at a time the wood shores were removed, and whenever this was done an additional tube section was set over the concrete-charged cylinder already in place. This, in turn, was poured full of concrete and a bearing plate was laid across the top. At the proper moment two hydraulic jacks were interposed between the bearing plate and the exterior wall girders, and pressure was applied in an effort to sink each of the concrete piles until the gage showed the desired test load. When the fourth floor above the street had been poured, the average load on each column of the building was approximately 75 tons, and then one pile of every group was subjected hydraulically to its final test load. The cylinders were designed to take a unit load of 50 tons, and to prove their fitness to do this each was called upon to withstand an overload test of 50 per cent. The average penetration as a result of this test was about 3 feet into the coarse sand stratum already mentioned.

As soon as a cylinder refused to sink deeper under a pressure of 4,700 pounds to the square inch, a steel beam, cut to fit exactly between the top of the cylinder and the underside of the footing, was interposed vertically and wedged in place before the load on the two 4½-inch hydraulic rams was released. This effectually prevented the rebound of the pile and maintained the "bulb of pressure" of the soil at the bottom of the cylinder, thus obviating a settlement of 2 inches or more which would have occurred had the ground had a chance to react before a subsequent application of the rams.

One by one, and at different intervals, each pile of a group was tested and a steel beam put in place. The beams were ultimately enveloped in concrete; and it is interesting to note that the last of the cylinders was not completed until the roof had been poured. As should be plain, this system of underpinning a building allows for the simultaneous erection of the superstructure and the forming of the foundation. Besides saving time and expense, the method enables the constructors to measure continually the strength of the substructure and to make certain that it will carry the overload without any danger of subsidence. And now let us see how the work was done during the wintertime on the other parts of this rather unique edifice.

Preliminary operations for the setting of the empty steel shells of the pretest piles were taken in hand during the first week in September of last year. The ground floor was begun October 1st and finished twenty days later, while the sixteenth floor was completed by the 24th of February, 1921. It is suggestive of the speed of progress that, owing to inclement weather, activities were halted for fifteen working days in this interval. The season's rigors were very largely nullified by precautions adopted which rendered it feasible to push right ahead when the thermometer was well below freezing temperature; and herein the engineers and contractors in charge of the operations gave ample evidence of their resourcefulness.

As soon as the first floor was set and shored so that it would be able to take any load of sand or stone which might have to be placed upon it, it was covered with planking, and upon this was laid a system of perforated steam pipes. This installation was so controlled by a series of valves that steam could be introduced at will into the pipes of any bay. At times the floor sustained loads up to 700 pounds per square foot. On it was built a tank large enough to hold sufficient water for four or five batches of concrete, and this water was kept pretty close to the boiling point by means of live steam. The concrete was poured into the forms hot, and as soon as a bay or section had been poured the steaming material was covered by tarpaulins which were secured to suitable battens. Further, heat was led from the salamanders into the space between the canvas and the surface of the solidifying concrete. Not once during the consummation of the

Jacking down a pretest pile by reaction against the overlying concrete girder

job was any of the concrete frozen. For the wall columns the forms were made of 1¼-inch lumber which, in addition to producing beautiful lines, proved to be an excellent insulator against the cold. Heavy tarpaulins were draped over the outside of the building to hold the frost away from the concrete; and inside the structure glowing salamanders were disposed close to the walls.

During the execution of the task it was customary to pour a floor about once a week, and this speed of construction demanded that great care be exercised to prevent overstressing the fresh material. To this end five floors at least were regularly shored so as to afford a wide distribution of the load throughout the ripening period of the concrete. The engineers left nothing to guesswork in determining the actual strength of the concrete used, and they devised an ingenious way of testing the material at different times while it was maturing. Promptly after a floor slab had been poured a dozen galvanized iron cylinders, each 6 inches in diameter, were pushed into the plastic stuff. These cylinders were encased in pasteboard mailing tubes, which rapidly disintegrated, thus facilitating the withdrawal of the concrete-filled cylinders whenever desired. Samples were obtained in this manner successively at the end of one, two, three and four weeks, which permitted the experts to determine to a nicety the physical properties of the concrete as it ripened. This check upon the maturing process gave the engineers assurance that they could reduce the number of floors shored in safety whenever, to save time, this action was expedient. The concrete employed, *i. e.*, of 1:2:4 composition, attained a strength of fully 1,800 pounds in the course of 28 days. Slump tests were made daily.

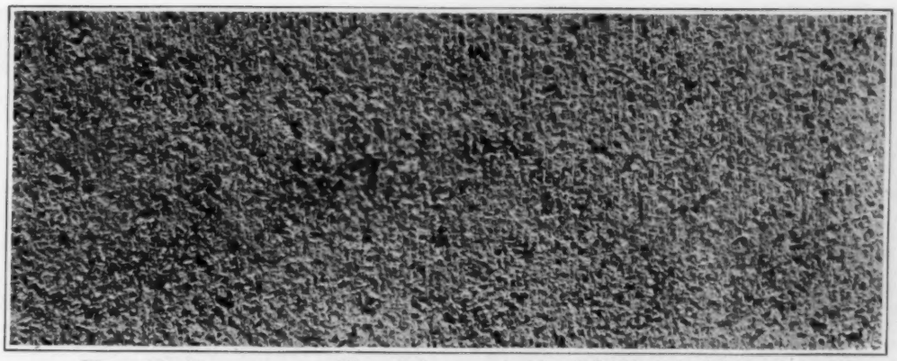
Objection to reinforced concrete in tall buildings has often been advanced on the score that the columns would be uneconomical by reason of the large amount of floor space occupied by them. But in the case of this structure the critic has been answered by the adoption of ground-floor columns of not more than 38 inches diameter, and this in the face of the fact that columns in lower buildings of considerably less floor-carrying capacity have been installed of quite 48 inches diameter. In the present instance this marked saving in space has been achieved through the use of special steel reinforcement and a particularly rich concrete. In this structure it has also been found practicable to employ concrete curtain walls only 8 inches thick, whereas brick curtain walls in a steel frame building would have to be 12 inches thick to satisfy the City Building Code requirements. This gain of 4 inches in space around the entire perimeter and on each floor of the edifice is a matter of considerable moment.

In order to insure accuracy of line and a very nice adherence to prescribed contours, both foresights and backsights were taken on neighboring buildings before the column forms were set; and at frequent intervals during the various stages of erection the surveyor and his transit were employed to check up alinement. These precautions have insured results that are quite as good as those obtained with steel framing.

Flat steel slab form-plates were used uniformly in the construction of the building. They were 2 feet by 8 feet, and throughout their area produced absolutely smooth ceiling surfaces. These metal plates, owing to their conductivity, served admirably to distribute the heat from the salamanders—thus hastening the drying out of the concrete. The depressed panel forms were also of steel; and it seems that the application of the metal form-plates proved somewhat less expensive than wooden ones would have been for the same work.

Heretofore a considerable dimensional variation has been allowed in reinforced concrete structures, but in the present instance it was necessary that the elevator shafts should be kept to guaranteed measurements and vertically true, so that the cars could be ordered early enough to have them delivered promptly. When the building was only two stories high, the size of the cars was fixed; and from then on the elevator contractor was able to install his guides with the completion of each succeeding floor. Cars were in service in two of the four shafts a full month before the skyscraper was turned over to the owners.

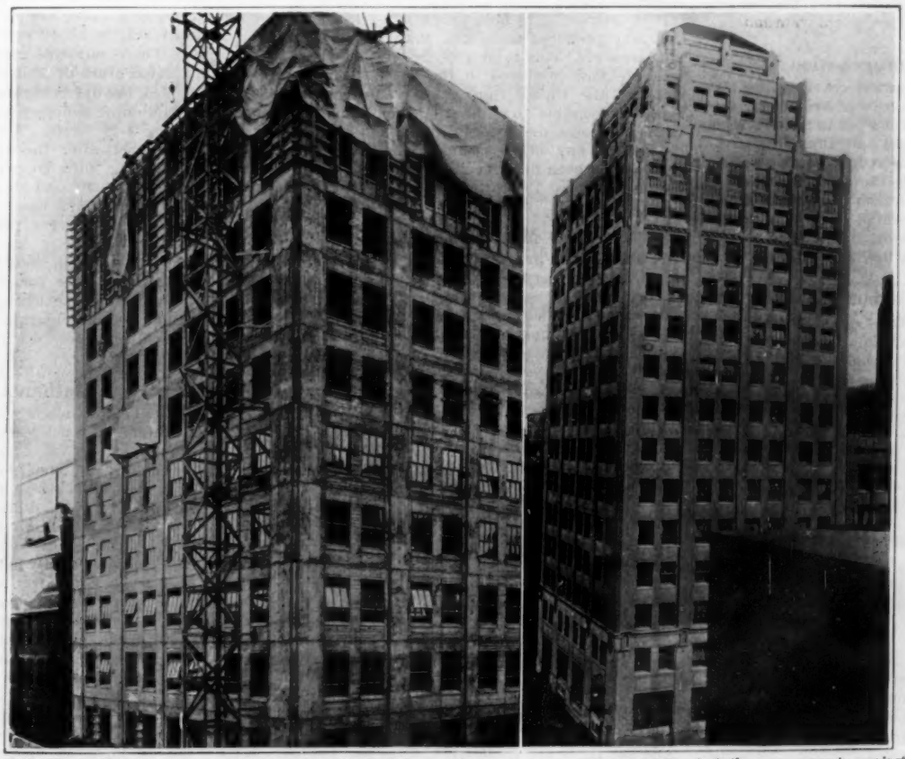
The exterior surface finish is a feature deserving mention, because concrete buildings are all too often not pleasing in this respect. An unusual method was resorted to to assure satisfaction. Instead of employing cut limestone or molded concrete blocks as a facing for the two lower floors, the engineers, in order to carry out the monolithic effect in its entirety, adopted the novel expedient of casting the stone finish in place. No change was made in the manner of fabricating the steel reinforcement, other than that ½-inch expanded metal was wired to the rods. The space usually devoted to fireproofing was filled instead with surfacing concrete.



The granite-like appearance of the exterior concrete after it has been bush-hammered

The distance between the expanded metal and the outer form varied, according to requirements, from 1½ to 2 inches. The surfacing concrete was hand mixed and rather dry, and when ready was guided by means of a broad, flat chute into the narrow space between the expanded metal and the outer form. When in position the material was vigorously tamped with a tamper of special pattern. The structural concrete was poured between the expanded metal and the inside form. The facing concrete was handled so as effectually to prevent structural concrete from working outward to the exterior. This surfacing material was composed of white Portland cement and two parts of colored aggregate made up of quartz, feldspar and green-stone chips. When suitably seasoned this composition was bush-hammered by stone masons, and this treatment produced a beautiful effect. The upper sixteen stories were surfaced by electric carborundum grinding machines, in accordance with recognized standard practice.

The interior concrete was likewise finished by using electric carborundum grinding machines, and none of it was plastered. After grinding, it was sandfloated with wood floats. To facilitate this work, special take-down rolling scaffolds were built, and these enabled the operatives to forge ahead easily and speedily without waste of time. The final results are quite as good as sandfloated plastering, much more permanent and considerably less costly. Once more we have proof of the adaptability of concrete for structural purposes; and in rearing this skyscraper we are given evidence of the resourcefulness and the inventive cunning of the men who are bent upon making the most of this flexible building material. At a very recent date such a structure as this one would have been regarded as altogether out of the question.



Left: The building during erection; the tarpaulins draped over the two topmost stories are to protect the new concrete against frost. *Right:* The finished structure—tallest building yet reared of reinforced concrete throughout

The Hide and Leather Building, New York

Water Regulation in the Body

IN a paper on "Water Regulation in the Body," in the *Journal of Physiology* (London) for March, Mr. E. F. Adolph, of the University of London, says: The addition to the body of water, alone or accompanied by various salts or urea, is not permanent. The solution retained for the greatest length of time is 1 per cent sodium chloride. Water may be abstracted from the body by a large variety of methods, several of which have been studied comparatively. When no other constituent has been abstracted meanwhile, the body-weight is completely restored by drinking water. Depletion of water does not inhibit the process of growth, though it seems that the contrary might be anticipated. The excretion of water, chloride, and urea during a diuresis due to any one of them is by far the most accurate indication so far at the disposal of the diagnostician for indicating whether the water of the body is normal in quantity.

The water content of the whole organism is independent of every other single substance. The content may be raised by introducing a temporary store of salt or carbohydrate; this water is not a part of the essential structure of the body. Other than this, no evidence has been found for a reserve of "free" water, and in thirst the excretion of water is kept up at the expense of water from the tissues themselves. This is the means whereby death from thirst is effected.

The Service of the Chemist

A Department Devoted to Progress in the Field of Applied Chemistry

Conducted by H. E. HOWE, Chemical Engineer

Filtering with a Powder

WHILE manufacturers are familiar with the use of coagulating agents as aids to filtration and have developed many serviceable filtering mediums, the use of a powder seemed to many of them like adding more objectionable material rather than removing it. But experiment has shown that the diatomaceous earth which is prepared for this purpose serves to keep open the pores of the filter cloths and in power presses builds up a porous cake through which the material to be filtered passes, readily giving up its impurities meanwhile.

This powdered earth is able to overcome the slimes which cause so much trouble in food work. In filtering cereal beverages ¼ pound per barrel permits the use of the modern pressure filters, and the filtrate is brilliant and clear. Yeast cells are entirely removed. Fruit juices and apple products are mechanically clarified when small quantities of this type of powder is added before filtration, and catalytic agents, used in the hydrogenation of oils, are removed by filtering with it.

Another important application is in the clarification of crude and refined vegetable oils when its use decreases the amount of bleach required. Soap lyes and fats are clarified by using 0.1% of the diatomaceous earth.

Handbook on Shellac Industry

THE Indian government has included as a part of its publications "Indian Forest Records," a "Report on Lac and Shellac," which should command the attention of those interested in that important article. Of commercial interest are lists of the principal manufacturers, dealers and exporters in the lac centers. Then there is a bibliography on lac and shellac and reports of investigations into sources of supply, methods of production, manufacture, transportation, price fluctuations and volume of exports. Comprehensive colored maps are included, price graphs and the influence of stocks upon prices.

In the discussion of quality of shellac reference is made to the influence of cultivation and method of preparation and there is a deal of technical information.

A Catalyst for Hydrogenation

A BRITISH patent has been issued covering the use of a nickel wool, which has been activated, for the hydrogenation of fats. The nickel wool is treated with nitric acid after which the nickel salt thus formed is converted into the oxide and this reduced in hydrogen. This activated wool is packed in the reaction chamber through which the oil and hydrogen pass in countercurrent. The catalyst is regenerated by washing with hot oil to remove the nickel soaps, then removing the oil with solvents and finally heating in hydrogen.

Tests on Commercial Carbon Monoxide Indicators

THE Gas Mask Laboratory of the Bureau of Mines has been testing commercially produced instruments in which iodine pentoxide indicator is used to detect carbon monoxide. The results show that the instrument gives positive indications by the change of color with 0.07% or more carbon monoxide in air. By comparison with a color scale an average of 0.16% was obtained for air containing 0.15%, the lowest reading being 0.10% and the highest 0.23%. With an increase in the amount of carbon monoxide about the same order of variation was observed.

Air carrying smoke or flue gases caused no difficulty, while determinations at freezing temperature and in artificial light were also good. Only one person in thirty experienced any trouble in determining color shades. The gases which might interfere with the test are removed in the apparatus by activated charcoal. These are acetylene, ammonia, benzene, ether, ethylene, gasoline, hydrogen chloride, hydrogen sulphide, water vapor and natural gas containing members higher than methane. The following gases can be ignored: sulfur dioxide, phosgene, methane, nitrogen peroxide, chlorine, carbon dioxide and carbon tetrachloride.

No skill is required to make these determinations for carbon monoxide and less than a minute is required.

Zinc vs. Copper Roofing

MR. FREDERICK LAIST, of a prominent copper mining company, in an address before the annual meeting of the American Zinc Institute made some interesting comments on zinc and copper roofing. Zinc sheets are used for roofing abroad, but have not been extensively applied for such purposes here. Copper, however, is extensively used; but, as Mr. Laist points out, copper must command a much higher price than zinc, and under ordinary conditions costs twice as much to produce as zinc. Copper seldom costs less than 15c per pound to produce. To quote from the address:

"For ordinary roofing purposes copper can scarcely be considered a competitor of zinc on account of its necessarily much greater cost. While the average person is willing to pay one or two cents, or probably three cents, per pound more for it, he is likely to think a long time before paying seven or eight cents per pound more.

"Now, as regards the comparative life of the two materials. The converter building at the Anaconda reduction works afforded a very difficult roofing problem, and many kinds of roofing were experimented with. Corrugated iron was first used and had to be replaced about every eight months. About ten years ago it was decided to replace part of the roof with copper, which is still in fairly good condition, although some sheets have had to be replaced, owing chiefly to lack of physical strength rather than chemical corrosion. Thicker sheets should have been used. After we became interested in zinc, we decided to try out some corrugated zinc sheets on the roof of our converter building. These sheets, while they have stood up remarkably well, are not as good as copper and show the corrosive action of the sulfur gases. These sheets, too, are thinner than they should be, and, therefore, lack physical strength. However, they stood the test better than might be supposed, considering the extremely severe conditions, and have convinced me that zinc roofing for ordinary purposes would last so long that the question of life would not be of importance as determining the choice between copper and zinc."

It is interesting to note that last April the Anaconda Company produced more zinc than copper in its Montana smelters. This is electrolytic zinc, of which 125,000 tons are now produced in the world—nearly one-half being in the United States. The electrolytic process makes it possible to mine zinc from a much greater variety of ores and concentrates than can be accomplished by any other means. The technique of the process has been described recently in the transactions of the American Institute of Mining and Metallurgical Engineers.

Mineral Tannage

IN his fourth article on this subject in *Collegium*, W. Moeller discusses the tanning action of iron salts. He concludes the usual explanation of the instability of iron tanned leather, that it is due to oxidation, is not correct since intact hide substance is very difficult to oxidize. Iron salts have a strong tendency to ionize, and the ions, especially hydrogen ion, cause hydrolysis of the hide substance in the leather. Organic salts are beneficial since they repress this hydrolysis. The slight tanning action of unneutralized iron and chromium salts is due to the fact that the hydrolysed hide substance acts as an alkali, neutralizing a small amount of the salt and thus setting up a peptized or tanning system.

Wages in Chemical Industries

A RECENT report made to the Ways and Means Committee of the House states that the weekly wages paid to semi-skilled men in the chemical industry of various countries is as follows:

United States	$31.03
Great Britain	18.71
Norway	16.32
Germany	6.34
Italy	5.04
Japan	4.90
Belgium	3.74

And yet there are those who fail to see why our chemical industries need special provision to establish them and encourage development!

Bacteria and Corn Cobs

MR. W. H. PETERSON, of the University of Wisconsin, has found that 100 pounds of corn cobs can be made to yield 2.7 pounds of acetone, 6.8 pounds of ethyl or grain alcohol, and 3.4 pounds of acid, principally formic and acetic. This is accomplished by making a sirup from the corn cobs by hydrolysis with dilute sulfuric acid and then fermenting this. The sirup is chiefly xylose, and the bacteria which does the work is Bacillus acetoethylicum. Proper conditions of nitrogen and phosphate supply and hydrogen ion reaction must be maintained.

The fermentation is made continuous by providing cinders to which the bacteria may attach themselves in the container. The fermented solution can be removed and new sugar sirup added without disturbing the bacteria, and under these circumstances a rapid and vigorous action is maintained. The work to date has been done on a laboratory scale, and no figures have been compiled on the strictly economic phases of the research.

Pelt Dyeing

THE July issue of the *Journal of the American Leather Chemists Association* abstracts an article in the *Deutsche Farber-Zeitung* by O. Berthold on pelt dyeing as follows:

"After tanning, the pelt which is to be dyed is prepared by maceration in a 1–3° Bé. sodium hydroxide solution, then washed in a large amount of 0.5 per cent sodium carbonate solution. In place of sodium hydroxide, milk of lime, sodium carbonate or ammonia of corresponding concentration may be used. The temperature should not be above 30°. The skins are then washed free of alkali, are made slightly acid with acetic or formic acid and again washed. Mordanting previous to dyeing yields faster colors. The following mordants are recommended, the amounts in each case to be added to 1 liter of water: (1) potassium bichromate 2 grams, tartaric acid 1, copper sulphate 0.25; (2) potassium bichromate 2, tartaric acid 1; (3) potassium bichromate 2, acetic acid 1-2 cc. 30 per cent; (4) copper sulfate 5, acetic acid 1-2 cc. 30 per cent; (5) ferrous sulfate ⅝, acetic acid ½ cc. 30 per cent; iron liquor 20–50 gr. 30° Bé. These mordants may be used singly or in mixtures at temperature of 25–30°. For dyes ursols are recommended, the dye being formed on the hair by the oxidizing action of hydrogen peroxide, the complete effect requiring 4–18 hours. A fine deep black on rabbit pelts is obtained, after the usual preparatory treatment, by mordanting with copper sulfate and acetic acid for 15 hours at 30° and thorough washing, then dyeing in a bath containing ursol D 6 grams, ursol DG 2 grams and 120 cc. hydrogen peroxide solution for 15 hours at 30–35°. The pelts are then thoroughly washed and placed in a fresh cold bath containing copper sulfate 0.5 gm. per liter for 2–3 hours, centrifuged without washing, and the leather coated with a solution containing sodium chloride 200 gms., glycerol 100 and egg yolk 40 per liter, when the pelts are dried, stretched and finished."

Methanol from Methane

A PATENT covering a method for the production of methanol from methane has been granted to E. H. Riesenfeld. In the August 3 issue *Chemical and Metallurgical Engineering* abstracts the patent as follows:

"Methyl chloride is produced from methane by any suitable process and then in anhydrous alcoholic solution is converted into dimethyl ether by a process of heating with caustic soda under pressure. The dimethyl ether is subsequently hydrolyzed to methanol under high pressure. The latter reaction is accelerated by the presence of free mineral acid. The conversion of the methyl chloride is carried out in an iron receptacle containing ethyl alcohol and an excess of caustic soda under a pressure of about 20 atmospheres. The final hydrolysis usually proceeds very slowly unless fairly high temperatures are used. However, by the employment of certain accelerating agents, such for example as a 20 per cent solution of sulfuric acid, the reaction can be made to produce methanol on a commercial scale using a temperature of only 80 deg. C. The final reaction is carried out in tall, narrow iron cylinders.

The Camera Turned Sculptor

FROM England comes news regarding a new process of "photo-sculpture," which has been developed as the result of two years of incessant experimenting on the part of Mr. H. M. Edmunds of Brighton. By means of Mr. Edmunds' process a carving in greater or less relief can be made from a solid object by use of the camera.

From a British contemporary we learn that there is nothing to prevent a photographer of ordinary skill, given the necessary combination of camera and projector, from making the photographic record, which is all that is required for the carving machine; and when once such a negative is made it can be sent away to the works where the carving machine is operated, and any number of direct replicas in relief can be made from it, to say nothing of their reproduction by casting. The carving can be done either in relief or intaglio, at the will of the operator of the machine. As its name implies, photo-sculpture is a process by which it is possible to photograph a sitter or any suitable solid object in such a way that from that photograph a carving can be made in ivory, alabaster, wood, or other material.

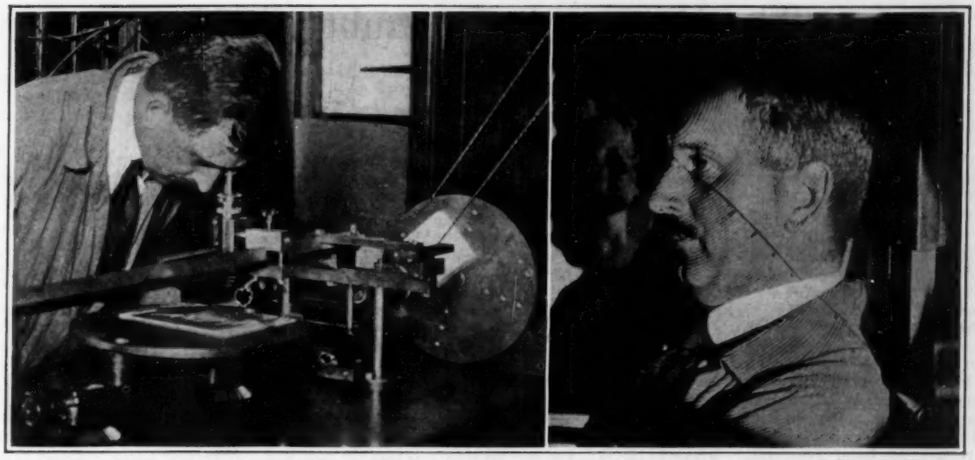
It is a little difficult for the ordinary layman to grasp how these carvings can be produced, and to understand the theory of their production calls for a knowledge of mathematics. However, Mr. Edmunds explains that it is necessary first to imagine an optical projector constructed for use with a very long focus and well-corrected lens and a powerful source of illumination. The inventor has used with success a gas-filled incandescent lamp of about 1500 candle-power. In place of the ordinary lantern slide an accurately drawn spiral photograph on a sheet of plate glass is used. This spiral has a form like that of the groove of a phonograph record. The spiral is projected and focussed upon a plane surface at a distance of about 10 feet from the projector lens. A camera is fixed to the side of the projector with the nodal points of its lens lying in the nodal plane of the projector lens. For all practical purposes it can be said that the optical axes of the camera and projector lenses are parallel, and that a line joining the centers of the two lenses is at right angles to these axes. A photographic plate put in the camera at right angles to the axis of the lens will photograph the spiral projected on the plane surface, and will do so without distortion.

The broad principle by which the carving is effected is that by substituting any solid object of an irregular form for the plane surface, the distortions produced in the projected spiral give a record of the object, and so provide means by which the carving can be effected. The photographic negative obtained is carefully enlarged on to an opal glass which is necessary, as the exact dimensions of the enlargement must not be altered by development, as would be the case if ordinary bromide paper were used.

We now turn to the carving machine in which the photographic record is utilized to produce a bas-relief of the sitter. The mechanical details of this machine are somewhat complex; but in its elements the machine consists of three parts: (1) A face plate, which holds the material to be carved; (2) a moving carrier, which holds the photographic record; and (3) a high-speed drill and microscope mounted up together, which can be moved in and out by a controlling lever. The operator of the machine merely has to follow the lines indicated on the photograph with the cross-hairs of the microscope, moving the microscope to do this with the controlling arm already mentioned. In moving this microscope he also moves the drill, so that it cuts the material at varying depths according to the form of the original subject.

Up to the present the inventor has worked with 20 and 40 lines per inch; and he finds that the latter gives a more delicate and faithful rendering of the original. Whether an increase beyond 40 would be better he cannot say, but he believes that 40 represents the detail quite closely enough when looked at from the ordinary distance of two or three feet. The movement of the carrier of the enlargement is made to correspond exactly to that of the carrier of the material to be carved, both movements being mechanically locked together for this purpose. Mr. Edmunds has good results in boxwood, mahogany, and ivory, but has found the greatest ease of working in alabaster.

With regard to degree of relief, this is a question which requires a good deal of attention, as certain subjects show up better with a relatively deep relief. The inventor has found that portraiture about a third to a half of the full relief of nature gives the best results.



Left: Carving machine, which translates a photographic record into a piece of sculpture. *Right:* Photographic record, showing the spiral effect

Apparatus which translates photographs into sculpture

Static and Gasoline Fires

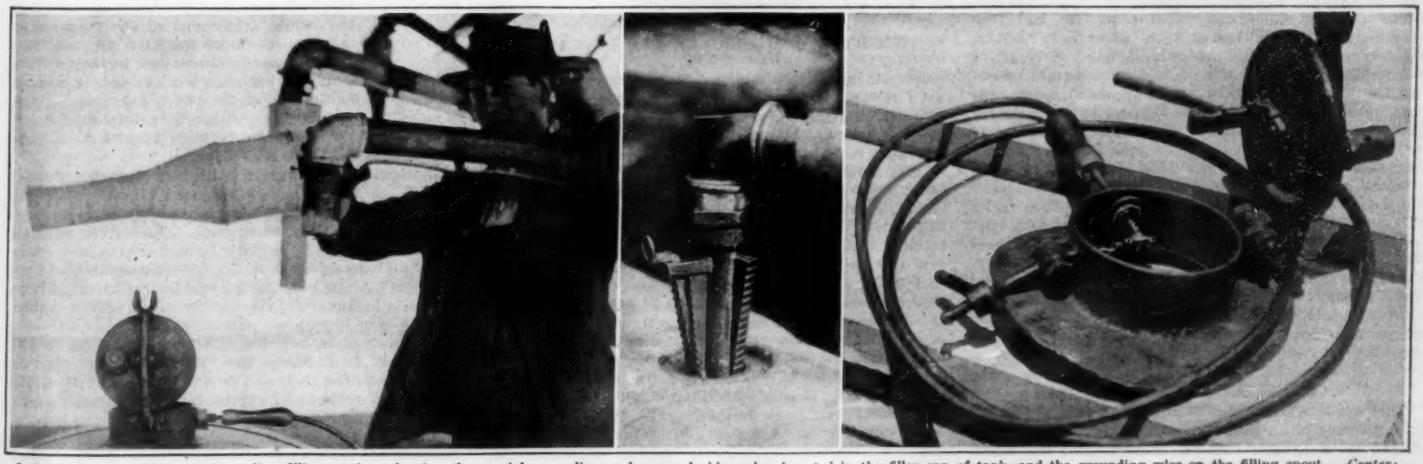
ONE of our large oil companies has experienced many fires due to the presence of static electricity either in the truck or service station, and to eliminate this fire hazard one of its employees has perfected the system shown in the accompanying views.

Each oil-filling pipe at the service station is provided with a plug. Before the driver can open the filler cap for the purpose of running gasoline or distillate into the tank wagon, it is necessary for him to insert the plug into a hole in the filler cap neck, as shown in our third view, which action unlocks the latch, thus permitting the cap to be opened. The act of inserting this plug carries off any static electricity which may be in the tank or truck chassis, thus removing any danger of a spark causing a fire when the filler cap is opened. The plug is connected to a wire which is grounded. There is also a wire connected to the end of the filler cap, which is also grounded. In order to complete the circuit a 5-16-inch chain is attached to the frame and allowed to drag on the ground at all times.

There is still another danger from fire, and that is when filling steel drums from a tank wagon. Some time ago a spark, which was caused when a drum was being filled on a ranch, started a fire which burned the tank wagon and the buildings on the ranch. For the purpose of eliminating this danger the oil company has perfected the device shown in the center view. This device is provided with a spring lock which holds the filling device firmly in the hole of the drum.

The service station presents about as complex a problem as can be found, owing to the numerous sources of static electricity. Under certain conditions refined oils passing through pipes generate static electricity. Each automobile comes into the service station charged with static, in some degree depending on the weather. Should we endeavor to insulate the car we would only create a still greater hazard due to heavy discharges; hence we take the opposite course and make the path so easy that the "building up" of a charge becomes unnecessary and the charges are harmlessly led back to earth. This easy path is what is known as "grounding," and it appears quite simple; but as a matter of fact the several conduits and the motor frame present a little problem all their own.

It would be well for all automobilists to give some thought to the static problem when handling gasoline. No doubt too little attention has been paid to this phase, with many serious accidents as a consequence. There is greater danger of static during crisp, cold, dry weather, than in warm, humid weather.



Left: Static precautions at a gasoline filling station, showing the special grounding and cap unlocking plug inserted in the filler cap of tank, and the grounding wire on the filling spout. *Center:* Tight-fitting plug which ensures absolute electrical contact with the hole in the gasoline drum, and therefore eliminates danger of sparks. *Right:* Details of the special grounding and unlocking plug for filler cap of gasoline tanks. The cap can only be unlocked and opened after the grounding plug has been inserted, thus removing any static charge

Some ingenious methods of grounding static charges and thus preventing the danger of gasoline fires during filling operations

The Heavens in December, 1921

The Mysterious Visitor of August, and Some Remarks about Comets in General

By Prof. Henry Norris Russell, Ph. D.

IT is not always an easy matter to keep a series of articles of the present sort strictly up to date—and difficulty turns to impossibility when the news of observations is delayed in reaching astronomers themselves. For example, information is still dribbling in regarding the bright object seen at the Lick Observatory last August. The group of aviators and astronomers who saw it on August 7th—as was told in these columns not long ago—were not the first to see the strange visitor. An amateur astronomer in Detroit noticed it the day before, about five degrees southeast of the sun. Then it was seen, at sunset on the 6th, by two amateurs in different places in England, and by at least one other in Germany. Two days later, an observation in the morning sky, before sunrise, was reported by a friend to Professor Douglas in Arizona—but details are not at hand even yet. Meanwhile, on August 8th remarkable bands of light were seen at Heidelberg, crossing the whole heavens, wide and bright as the Milky Way, and crossing it at right angles, which were at once suspected to be a comet's tail.

Putting all these data together, incomplete as they are, it seems certain that we have to do with a bright comet which passed perihelion late on the 7th or early on the 8th at a very small distance from the sun. It evidently came from south of the ecliptic, and receded sharply in the same direction, so that it was north of the plane of the earth's orbit for but a very few days. Under these circumstances it would have been so far south of the sun, when at any considerable angular distance from the latter, that there could have been no hope of seeing it except from stations in the southern hemisphere. Whether it was actually seen from some such point we do not yet know, and we must wait till the southern mails arrive to be sure.

It seems likely, however, that this will be one more of the instances—fortunately, rather rare—in which a comet may appear and vanish without a single observation being made of it which has the least claim to precision. The great brightness of this comet makes the case more remarkable—though it is improbable that it could fairly be classed among the "great comets." The last daylight comet, 1910 a, was observed in full daylight and was probably comparable with this one. Yet within a couple of weeks it had faded to an inconspicuous object for the naked eye; and if set up at the same distance from the sun and the earth, it would have been an inconspicuous object compared with Halley's comet, for instance. Even the latter would compare poorly with a really great comet, that of 1811, of 1882, or Delavan's comet of 1914.

The present comet may have passed nearer the sun than that of 1910, which did not come nearer than about ten million miles. But this will remain very uncertain unless further and more accurate observations turn up. Indeed, even if we had three accurate observations (which are required for the calculation of an orbit), the problem, for a comet which appears so near the sun, admits three solutions. That is, there are three possible orbits all of which would put the comet at the observed points in the heavens on the three given dates—though at very different distances from the earth. Just this happened in the case of 1910 a, and the first orbits which were calculated differed enormously; for some computers had hit on one of the three possible solutions and some on another. Later observations made it possible to tell with certainty which was right; but we may not have any of these this time.

Comets and Comet Searching

This whole episode emphasizes an opinion which has been growing in the mind of the writer, and is probably shared by many astronomers: namely, that the watch for comets has become rather slack since the war, and that it is probable that a good many are getting by undetected. This particular one to be sure may have been visible only to southern observers in the earlier part of its apparition; but the number of cometary discoveries has fallen off in a way that indicates clearly that something is wrong.

This affords an admirable opportunity for the amateur astronomer who has a fair-sized small telescope, a clear sky, and sufficient patience. Hunting comets is slow sport, but a year or two of honest work is likely to be rewarded. A dozen years ago an undergraduate at Princeton, Mr. Daniel, became interested in comet seeking, and in the three following years he discovered three comets—without spending so much strength as to interfere with his college work.

The comet hunter should provide his telescope with an eye-piece of low power and large field of view. He then goes out on a clear night, points his telescope anywhere in the sky, and sweeps slowly across the heavens, watching the stars as they pass through his field of view. When he has gone as far as he plans to go, he shifts his instrument laterally by an amount rather less than the diameter of his field of view, and sweeps back again, covering another long and narrow strip of sky, overlapping the first along one edge. Then he makes another shift sidewise and returns, sweeping out a third strip, and so on, as long as his patience will allow.

All through his search he is keeping watch for objects which are not star-like in appearance—faint hazy spots or lumps of light. If he finds one, the chances are that it is one of the many nebulae which are bright enough to be seen in small telescopes. Consequently he must know enough to be able to find out the right ascension and declination of the object at which he is looking, and he must have some sort of a catalog of nebulae for reference.

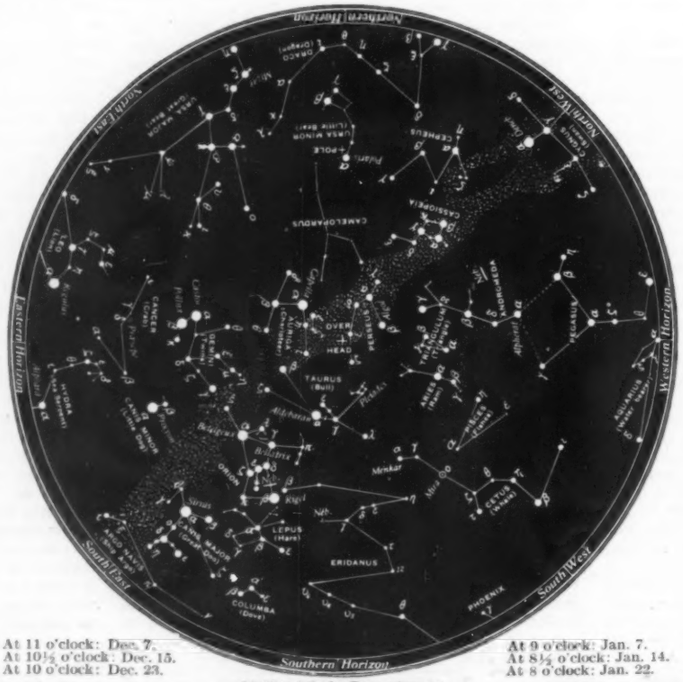
Sooner or later, if he does not become discouraged, such an observer will come upon some faint nebulous object which is not in the catalog of nebulae. He will then watch this with care, alining it with stars in the field of view, to see if it is in motion. If it moves it is certainly a comet and his next duty is to determine its position in the sky as closely as the time and means at his disposal permit, and then to send a telegram to the central station established by astronomers—in this country, to the Harvard College Observatory—announcing his discovery, and giving details regarding the comet's position, motion and brightness. The news will then be sent broadcast by wire, and other observers will get to work.

Though the labors of the comet seeker may be long, his rewards are considerable. Should he discover an "unexpected" comet (as opposed to one whose return has been predicted and for which an ephemeris has been published in advance), the comet will be known by his name and he will receive one of the medals which are regularly awarded for such discoveries by the Astronomical Society of the Pacific. There is a fair chance, too, that the comet may turn out to be of some unusual interest; it may be periodic, or may come near the sun or the earth, and be conspicuous to the naked eye. In such case the name of the discoverer bids fair to be long remembered in the annals of discovery. But more satisfying than these claims to fame must be the consciousness of the discoverer that he has made a definite addition to the sum of human knowledge, and borne his part in that laborious collection of data which forms the very foundation of the ever-rising structure of science.

The Heavens

As we go out in the December night for our usual survey of the skies, we find a splendid region in the southeast where Aldebaran shines high overhead. Betelguese and Rigel appear below with the attendant stars of Orion, and lower still is the incomparable Sirius. To the left and a little higher is Procyon, and beyond, still above, are Castor and Pollux. Almost under the latter is Regulus, low on the horizon, while above, close to the zenith, is Capella.

The Great Bear is coming up in the northeast, the Little Bear and Draco are below the pole, and Cassiopeia is high in the northwest. Pegasus is conspicuous in the west, with Andromeda above, and Perseus still higher. Eridanus and Cetus, which together fill the southwestern sky, have hardly a single bright star. Each of them, however, possesses one of the nearest of the stars visible to the naked eye—Epsilon Eridani and Tau Ceti. These two stars are both at a distance of about ten light-years—a little farther off than Sirius, but probably a little nearer than Procyon.



At 11 o'clock: Dec. 7.
At 10½ o'clock: Dec. 15.
At 10 o'clock: Dec. 23.

At 9½ o'clock: December 30.

At 9 o'clock: Jan. 7.
At 8½ o'clock: Jan. 14.
At 8 o'clock: Jan. 22.

NIGHT SKY: DECEMBER AND JANUARY

The Planets

Mercury is a morning star at the beginning of the month, and rises just before 6 A. M., so that he should not be hard to see. As the month progresses he draws in behind the sun and disappears, passing through superior conjunction on the 27th, and coming out as a morning star in January.

Venus is a morning star, and is also getting closer to the sun. On the 1st she is a little less than three degrees west of Mercury, and rises about ten minutes earlier, while at the end of the year she is only a little more than ten degrees from the sun, and is almost lost in the dawn.

Mars is also a morning star, but the sun is moving eastward faster than he so the two are drawing apart. He is in Virgo, and passes within four degrees of Spica on the 11th. At this time he rises at 2.30 A. M. and is therefore easy to see.

Jupiter and Saturn are still near together in the morning sky. Both are in Virgo but Jupiter, with his more rapid eastward motion, is receding from Saturn, while Mars, recently their near neighbor, is running ahead of both. On the 29th Saturn comes into quadrature and rises just at midnight—three-quarters of an hour before Jupiter, and two hours before Mars. Uranus is in Aquarius, visible only in the early evening, and Neptune in Cancer, observable after midnight.

The moon is in her first quarter at 8 A. M. on the 7th, full at 10 P. M. on the 14th, in her last quarter at 3 P. M. on the 21st, and new at 1 A. M. on the 29th. She is nearest the earth on the 17th, and furthest away on the 6th. During the month she passes near Uranus on the 6th, Neptune on the 18th, Saturn and Jupiter on the 22nd, Mars on the 23rd, Venus on the 28th, and Mercury on the 29th. The conjunctions with Jupiter and Mars are close, but neither is visible from our longitude.

Eliakim Hastings Moore

By Marcus Benjamin, Ph.D.

FOLLOWING the old rule that the office of the president of the American Association for the Advancement of Science should pass from a representative of the natural sciences to one of the physical sciences, this year a brilliant entomologist gives place to a distinguished mathematician.

Eliakim Hastings Moore is the son of the Rt. Rev. David H. Moore and Julia Sophia Carpenter Moore, and was born in Marietta, Ohio, on January 26, 1862. His father was an eminent clergyman of the Methodist Episcopal Church, who served as an officer during the Civil War, attaining the rank of lieutenant colonel, and later, as a bishop in his church, was stationed at important posts. It was while his father was serving under Sherman that the son was born. His early education was received at various schools as his father filled pastorates in Ohio and Colorado, and he was fitted for Yale, where he graduated in 1883 with the degree of A.B. Then pursuing higher studies he received the degree of Ph.D., two years later, after which he spent a year at the University of Berlin.

On his return from abroad he turned to his Alma Mater, and during the years of 1887-9 he served her well as a tutor of mathematics. But a call from the West took him to Northwestern University, where from 1889 he was assistant professor, and during 1891-2 associate professor of mathematics.

In 1892 came the most important event of his career; for the University of Chicago, then at the beginning of its development, invited him to the chair of mathematics and he became a member of that brilliant faculty of young scientists who have made that university one of the most important factors in the history of the recent growth of education in the United States, and conspicuously in connection with its graduate schools.

From its beginning in 1892 till the present the history of the department of mathematics in the University of Chicago has been one of steady growth. Professor Moore is still the head of the department, but according to a recent catalogue he has with him a staff of seven associate professors and as many more assistants and fellows. The same authority shows that students may make a selection from 36 different undergraduate courses and from perhaps fifty graduate courses. Professor Moore has been exceedingly fortunate in both his antecedents and his environment and a review of the various departments of mathematics connected with universities in the United States would unquestionably show that the one in the University of Chicago is preeminent in the amount and importance of its original research, also in the number and importance of places that its graduates have been called to fill, as well as from the large number of its staff that have achieved the honor of an election to the National Academy of Sciences.

In addition to his professorial duties he has found time to devote much of his attention to original researches, but these have been exceedingly technical. They have been, for the most part, in that branch of mathematics known as General Analysis, particularly in that portion of the subject in which there is involved one or more general classes of general elements. In such cases effort is made to find by suitable determination of terminology and assumptions, general theories of which the classical theories are particular instances, and which for this reason have their central features in common. And so the general theory of linear operations, which is akin to integration, has been his favorite field of study. As typical of his thought may be cited his theory of linear integral equations in general analysis on generalization of the classical Fredholm Hilbert Schmidt theory, presented in 1911, and more recently his theory in generalization of Hibbert's theory of limited quadrate forms in an infinitude of variables.

His other activities have included the editorship of the Transactions of the American Mathematical Society (of which organization he was president in 1901-03) during 1899-1907; also since 1915 he has been an associate editor of the Proceedings of the National Academy of Sciences. During the World War he served his country as a member of the National Research Council and was chairman of its mathematical committee during 1917-18.

Doctorates of various kinds have been conferred on him in appreciation of his great knowledge of mathematics. These have included an honorary Ph.D. from Gottingen in connection with the unveiling of the Gauss-Weber memorial in 1899, and an LL.D. from Wisconsin; as well as a Sc.D. from his own Yale in 1909; and also Math.D. from Clark in the same year.

He is an Associate fellow of the American Academy of Arts and Sciences since 1901; a member of the National Academy of Sciences since 1901; and of the American Philosophical Society since 1905. His foreign societies include corresponding memberships in the British Association for the Advancement of Science; membership in the London Mathematical Society, the Deutche Mathematikes Vereinigung, and the Circolo Mathematico di Palermo, and he was a vice-president of the Fifth International Congress of Mathematicians held in Cambridge, England, in 1912.

Professor Moore joined the American Association at its third Washington meeting in 1902, and was advanced to the grade of fellow a year later. He naturally affiliated with the Section on Mathematics and Astronomy, and in 1910 was chosen a vice-president of the Association, presiding over the section at the fourth Washington meeting in 1911. The high office of President of the Association is almost without exception conferred upon the foremost representative of some special branch of science in the United States, and therefore Professor Moore's election at the Chicago meeting, held last December, at once indicates that in the opinion of his colleagues he ranks first among American mathematicians, a decision in which there can be no dissenting voice.

Zirconium, the "Mystery Metal"

ON account of various properties and uses that have been attributed in the popular mind to zirconium, it has at times been styled the "mystery metal," says the United States Bureau of Mines. An investigation regarding the preparation and uses of metallic zirconium and its salts has been conducted by the Bureau of Mines, and the results are just now made public.

Eliakim Hastings Moore, incoming president of the American Association for the Advancement of Science

The compounds of zirconium have numerous important uses and more uses will doubtless be found. Investigations in recent years have indicated that sintered or coherent zirconium metal is very resistive to acids; that it can be used for electrodes, and it probably will find metallurgical uses. A steel containing zirconium has been proposed for use in armor plate and automobile parts, and nickel-zirconium alloys have been suggested for high-speed cutting tools and for cutlery. Numerous articles in scientific journals have recommended the use of zirconium oxide as a refractory, an abrasive, a pigment in paints, and as an opaquing agent in enamel ware. The salts have been used in the textile industry as a mordant or dye-fixing agency, and also for weighting silk.

Zirkite firebrick are used for furnace lining as well as for other purposes where a refractory having a low coefficient of expansion, high melting point, and maximum resistance to slag corrosion is demanded. Although zirconium oxide has not proved satisfactory for gas mantles nor for arc lamps, it has been used for polishing powders, insulators for both heat and electricity, and with fair success in the Nernst lamp. Being absolutely non-poisonous, zirconium oxide is finding a use in paints and lacquers, where its resistivity to physical and chemical agents is proving highly valuable. As an abrasive, zirconia, zirconium silicide and zirconium carbide are suggested for a variety of uses, the carbide particularly as a substitute for the diamond in cutting glass. Zirconium oxide, because of its non-toxic nature, is used in place of bismuth, nitrate or carbonate in Roentgen-therapy. It is also said to have some medicinal value. Zirconium oxide and nitrate have been suggested for use in the extraction of oxygen and nitrogen from the air. There have also been statements to the effect that the oxide may find use as a filler in the manufacture of rubber goods.

In flashlights, amorphous zirconium, mixed with certain oxidizing agents, burns with a bright light; but it is doubtful whether the metal would be cheap enough to use in place of the usual material. Coherent white zirconium metal, on account of its acid-resisting properties, has been suggested as a substitute for platinum in certain cases. Its alloys have been suggested in the manufacture of rust-resisting apparatus. Crucibles prepared from zirconium oxide were proved in the experiments of the Bureau of Mines to be superior for high temperature work to any crucibles procured on the market.

Zircon is found in considerable amounts in many placer deposits derived from disintegration of granitic and pegmatic rocks. The best known deposits in the United States are near Green River, Henderson County, N. C., and in the Wichita Mountains, near Cache, Okla. Zircon is found most abundantly in certain syenites of Norway, and occurs in crystalline limestone at Grenville and elsewhere in Canada. Dana states that zircon occurs in various localities in North America, including Litchfield, Md.; Essex County, Orange County, and in St. Lawrence County, N. Y.; near Reading, Pa.; abundantly in the gold sands of Burke, McDowell, Polk, Rutherford, Henderson, and other counties in North Carolina; with astrophyllite, etc., in the Pikes Peak region in El Paso County, and at Cheyenne Mountain, Colo. In California and elsewhere it occurs in gold-bearing gravels.

Baddeleyite (brazilite) is found in large deposits in Sao Paulo, Brazil. This mineral has also been identified in Ceylon, Sweden, Italy, and Montana. Samples of zircon sand from Pablo Beach, Fla., have been investigated, and recently as much as 3 per cent of some of the auriferious sands of Idaho has been found to be zircon mixed with some monazite.

In Brazil, which is an important source of industrial ores, it is difficult, owing to the hardness of the ore, to drill holes for explosives, and in handling large amounts resort is had to quite primitive methods. A large fire is built against an exposed face of the ore and kept burning for several hours, at the end of which time water is thrown upon the ore, which produces fracturing of the mass, permitting it to be sledged into pieces easily handled by one man. Most of the mines are many miles from the railroad. Horses for other than saddle purposes are practically unknown, and the ore is transported to the railroad station by oxcarts carrying about one ton each. These carts are of the crudest character, having large, solid, wooden wheels, some 4 feet in diameter and 6 inches in thickness. From 20 to 30 oxen are generally required for each cart, owing to the mountainous roads.

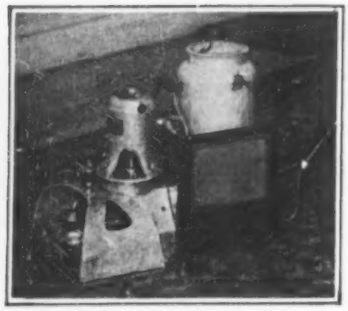
A New Fire Alarm Operated by Smoke

A NEW form of fire alarm has been invented in England. It depends upon its action on the presence of smoke and is not affected by temperature changes which usually are the chief factors in the operation of most fire alarms. The smoke detector consists of a metal cylinder some 8 in. long and 2 in. in diameter, open at each end, so that air can circulate freely through it, and containing two rectangular metallic capsules, one of which is considerably larger than the other. The detector, only one of which is required for each apartment to be protected, is fixed in a high central position, to which the smoke on the capsules is to cause one to bend more than the other. The differential movement is employed to complete an electrical circuit through a relay, and, by means of the latter, a large electric bell or other alarm signal may be operated. The apparatus can be used either independently or in conjunction with detectors depending on temperature effects, but it is said to have the advantage over the latter, that its action is more rapid and reliable. In many fires dense smoke would be produced before any material rise in temperature occurred, and, moreover, the smoke would rapidly fill the whole apartment while the temperature rise would remain purely local for some little time.

More and more the advantages of fire detectors of one type or another are coming to be appreciated, especially in country homes. This, in large measure, is due to the fact that the fire detector is a fit companion for the handy fire extinguisher, which is such an effective means of combatting a fire if taken in the early stages.

Inventions New and Interesting

A Department Devoted to Pioneer Work in the Arts



Carpet renovator for home use

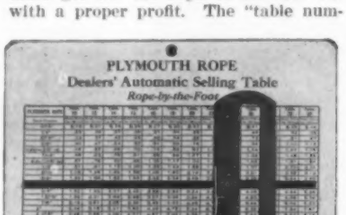
Carpets Cleaned at Home

NO longer need the busy housewife pick up her carpet and send it to the factory to be cleaned. She can have it done right in the house and on the floor. A new machine has been invented and is being used with success. The machine looks somewhat like a vacuum cleaner. In the container that is shown mounted on top of the carrier a solution of hot water and pure soap is dissolved. It runs through a superheater at the side of the car through a regulator which allows the liquid to flow on the inside of two bath-sponge applicators. These scrub the transformed water into rich soapsuds while oscillating at the rate of 500 revolutions per minute. Behind this is a squeeze-rod which squeezes the moisture from the carpet or rug, at the same time sucking up all the moisture and dirt into a lower container in the machine and leaving the carpet almost dry. Though water is used as indicated, the results are in no sense less unsatisfactory than those we have learned to expect from dry-cleaning.

A vacuum cleaner for the car upholstery

Prices per Pound and per Foot

RETAIL dealers in cordage and rope find as a regular thing that they must sell it by the pound, since this is the basis on which it is bought. But the customer wants to buy it by the foot, since that is the way he uses it. The dealer who is asked how much a given length of a certain rope will cost has no means of answering the question save by cutting off this length and weighing it; and if the customer then decides that he can afford a better grade or that he must make a poorer one do, there is a loss. So one rope manufacturer has carefully figured out the weight per linear foot of all his ropes, and has put the result up in a most convenient form. The dealer has only to figure the price per pound which he must get for his rope to let him out with a proper profit. The "table numbers" at the heads of the columns on the chart correspond to these prices in a simple way; having decided on his price per pound, the dealer picks out the appropriate column and confines his attention to it. The slide can be centered on any desired column, and the chart then tells how much 100 feet—and by simple calculation how much any other length—of each style of rope must bring. In this way the dealer can buy by the pound, as he must, and sell by the foot, as his customers must insist upon his doing.



This chart translates buying prices of rope by the pound into selling prices by the foot

Cleaning the Closed Car

A NEW vacuum cleaner, designed and built primarily for cleaning the upholstery of closed cars, has just been put upon the market. Every owner of a closed car knows what a problem it is to get rid of the dust and dirt that settles in upholstery. It is the most difficult kind of dirt to dislodge, and yet it quickly yields to the vacuum method. The powerful suction rapidly draws the grit into the dust sack as it is loosened from the upholstery.

The cleaner is portable and easily carried about from place to place, and very convenient to operate. When in use it is placed on the ground outside the car, away from the operator, and not interfering with his work. A 10-foot length of flexible hose is furnished, on the end of which is attached a swivel hand-grip or nozzle. This construction permits freedom of motion at all angles, regardless of how much the hose is twisted about. The brushes, of China bristle and leather bound, will not injure the most delicate fabrics.

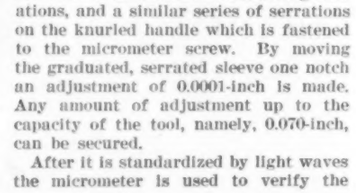
An Accurate Internal Micrometer

IN the manufacture of special tools, and in the duplication of accurate machine parts, difficulty often is experienced in measuring bores with extreme accuracy. To facilitate the taking of accurate internal measurements the tool shown in the accompanying illustrations was developed.

The operating mechanism involves four measuring jaws having a line contact with the internal cylindrical surface to be measured, and a micrometer screw that controls and registers the position of the jaws as they are moved in or out on inclined supporting surfaces. The four measuring jaws, which are provided with accurately ground and lapped cylindrical surfaces, are supported and held in alinement by close-fitting dovetail slots. A longitudinal movement of the measuring jaws of 0.005-inch increases or decreases the diameter of the measuring surfaces 0.001-inch. As the longitudinal movement is recorded with a micrometer screw, extreme accuracy is assured. Elimination of backlash in the micrometer screw and a close fit in the dovetail jaw grooves produce a tool that is practically as firm as a solid plug gage.

Provision for taking up wear is provided by a series of serrations on the sleeve that carries the micrometer graduations, and a similar series of serrations on the knurled handle which is fastened to the micrometer screw. By moving the graduated, serrated sleeve one notch an adjustment of 0.0001-inch is made. Any amount of adjustment up to the capacity of the tool, namely, 0.070-inch, can be secured.

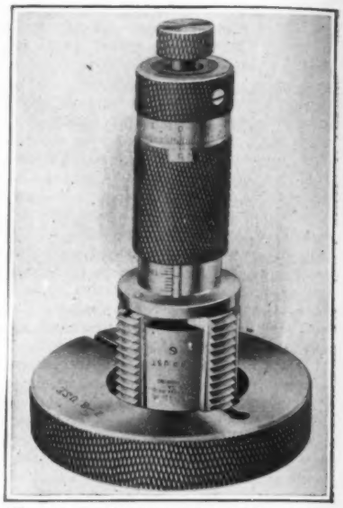
After it is standardized by light waves the micrometer is used to verify the master reference ring gage that accompanies it. The series of concentric holes in the ring gage is provided to facilitate air circulation, which permits the ring to accommodate itself rapidly to normal temperatures after it has been heated or cooled in use.



The internal micrometer being checked up on its master reference ring-gage

In use, the micrometer is easily manipulated. It is inserted in the hole to be gaged with the jaws undersize and the micrometer head is turned until the jaws are stopped by the surface being measured. By referring to the reading the amount is readily ascertained.

The manufacturers of this ingenious tool have gone a step further, and provided also an internal thread micrometer. This corresponds in every detail to the plain internal micrometer, except, as indicated in our picture, for the use of threaded measuring jaws in place of the plain ones of the simple instrument. These jaws may be had with any desired number and style of threads, and the instrument is sufficiently rigid, in spite of its control from the micrometer screw, to insure that when the threads are once set in continuation of one another so that the apparatus will take the threads of the hole being gaged, they will remain in this adjustment.



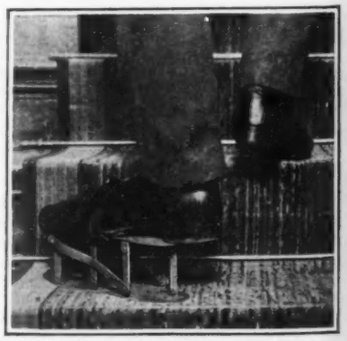
The internal micrometer with screw-gaging attachment

To Help the Short-Legged Man Upstairs

WOUNDED or slightly deformed persons who have one short leg, but who do not under ordinary circumstances need to advertise their infirmity by wearing a shoe of extra height, find nevertheless that in going upstairs their difficulties are materially increased. A French inventor has brought out what he calls a step-slipper for use in such cases. Its construction follows closely the lines of the conventional open-bottom cripple shoe, but as the illustration at the bottom of the column indicates, it slips on and off with a motion of the foot, much after the unpleasant habit of the familiar bath slipper, which is always falling away at the heel.

The Theft-Proof Car

THE latest thief-proof attachment for the automobile, while a diagram showing its operation would be rather complicated, is extremely simple in form and not difficult to install. It con-



A shoe for the use of the slightly crippled, in going upstairs

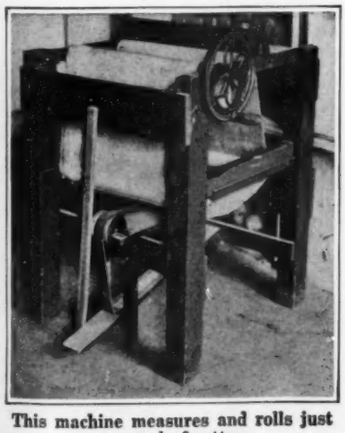
When the circular disk is replaced by the diamond one, the engine is without a spark

sists of a two-way switch mounted on the mud-guard, and wired up in such a way that the ignition current must pass through it. This it can only do when the round disk shown in the photograph is in place and locked in. On leaving the car, the owner removes the round disk and puts in its place a diamond-shaped one. This not alone fails to close the ignition circuit, but it completes a secondary circuit in such manner that any effort to tamper with it, to remove it without unlocking it, to short-circuit the ignition current around it, etc., will result in setting off a loud warning siren.

One Pound of Cotton

"ROLL your own," an injunction of the cigarette-tobacco manufacturer, is a phrase that now has significance in the preparation of packages of cotton for marketing. A machine designed by J. F. Barghausen, investigator in agricultural technology of the United States Department of Agriculture, is capable of rolling cotton into one-pound packages for length standards as prescribed by the Bureau of Markets in the marketing of the staple crop.

The simple device consists of an endless canvas belt adjusted on four wooden rollers, one of which is so arranged as to tighten slackness as desired. This roller is controlled by a foot lever, subject to the manipulation of the operator. One of the top rollers is in a receptive mood for opening in admitting the one pound of cotton on the conveying belt. The roller is then closed, and a hand wheel—in this instance a wheel from a coffee-grinding machine—is turned by hand half a dozen revolutions. The roll is thus formed. In this position the paper for covering the package, with an adhesive sticker on one end, is inserted and automatically travels around the potential bit of cloth. A few turns of the wheel secures the covering around the cotton.



This machine measures and rolls just a pound of cotton

Until recently length types of cotton in the standardization of the product were prepared by hand. Cotton specialists of the Bureau of Markets, drawing salaries ranging from $3500 to $4500, tediously converted the soft substance into one-pound packages altogether by hand. Four men, working all day, rolled forty of the small bundles. By the use of the newly built machine, 110 packets are bundled in eight hours and the services of three cotton specialists may thus take more useful directions.

The Motorcycle Spray

FIVE hundred and ten acres of potatoes, owned by a Washington state rancher, were in danger of destruction by the potato bug. The little pests were working so fast that it did not seem as though any means of extermination could possibly keep up with them, let alone catch up with them. But the rancher was a resourceful soul, and he attached an insecticide-spraying outfit to the side-car chassis of his motorcycle, utilizing the power of the machine for traction and for spraying. With this outfit he found it possible to spray 190 acres per day with Paris green, whereas a horse-drawn sprayer would by no expedient have been able to get above 35 acres.

This motorcycle carried a spraying outfit over 510 acres in less than three days and saved the potato crop

With the exceedingly hot, dry weather that was so general during the past summer, a day's delay might well have spelled ruin for the crop; but the motorcycle saved the situation.

A Swivel Arm Micrometer Holder

SWIVEL-CHAIR officers were freely criticized during the war, but a swiveled arm developed by the U. S. Bureau of Standards was an important factor in holding micrometers for measuring pitched diameters of screw threads for the Ordnance Department. The simple device is likewise of value in times of peace when the production of thread gages is essential, the swivel mechanical arm filling a niche where the operator is unable to supply a third hand.

Formerly in testing screw threads a rigid mechanical arm was used, the apparatus holding the micrometer rigidly with the faces parallel to the axis of the gage, which in this instance was necessary with the use of two wires. The three-wire method of measuring screw threads is preferable, using the flexible arm which leaves the micrometer with a free movement in taking up its position with its faces parallel to the axis of the gage. Likewise, the observer who is the possessor of only two hands finds machinery coming to the rescue.

A Safety File for the Home

HERE is a new and novel semi-fireproof filing cabinet for the home. Just the thing in which to file away insurance policies, lodge dues, cancelled checks, notes, certificates, coupons, bonds, gas bills, grocery bills, clothing bills, private letters, or anything else that is important to put your hands on when the occasion demands.

The average home has important papers of all kinds scattered all over the house, in bureau drawers, in vases, on shelves, in books, underneath dresser scarfs, in closets and in a hundred and one other places where half the time they cannot even find them themselves.

Oftentimes this is the cause of serious delay and embarrassment. In the case of a fire, these papers, which likely as not include the insurance policy, could not be saved. It is not because people are careless, but it is because they have really no one good safe place to put everything of value. The new holder encourages system. It not only serves every purpose of a safe, but with an index it classifies everything the minute you drop it in.

This file is made of the best grade of thin, highly polished automobile-fender steel, size 6x10x12 inches, holding 1000 full size business letters. The weight is only four pounds without the index. There are no bolts or nuts; everything is securely riveted together.

The Illuminated Seat Diagram

ALL of us have had the experience of poking and groping about in the darkened motion picture theater for a seat that we were not at all sure was there. A California invention will obviate at least the uncertainty, if not the groping. When there is thirty pounds pressure, or more, on the seat, nothing happens; when there is not, the seat sits high enough, on the top of a light spring, to insure that a contact will be made that will light the lamp corresponding to the seat in the diagram displayed at the door. No light, no seat; so all the incoming patron has to do is pick out the seat he wants and make for it.

Why Fire Departments Are Motorized

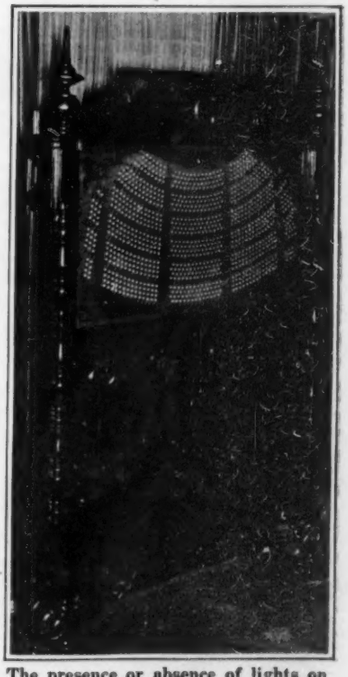
THE annual report of the fire department of La Crosse, Wis., impressively illustrates the economy of motor-propelled over horse-drawn equipment. Three triple combination trucks now in service traveled 761 miles to respond to 298 alarms during 1920 at a total expense to the city of $602.89. During the same period fourteen horses used by the department consumed feeding stuffs costing $2,433.13, and the horseshoeing bill for the year amounted to $683.90 additional. The recommendation that three additional trucks be purchased at once, supplanting nine horses, probably will be carried out without further delay

Semi-fire-proof file for home and general use

Time Combination Lock

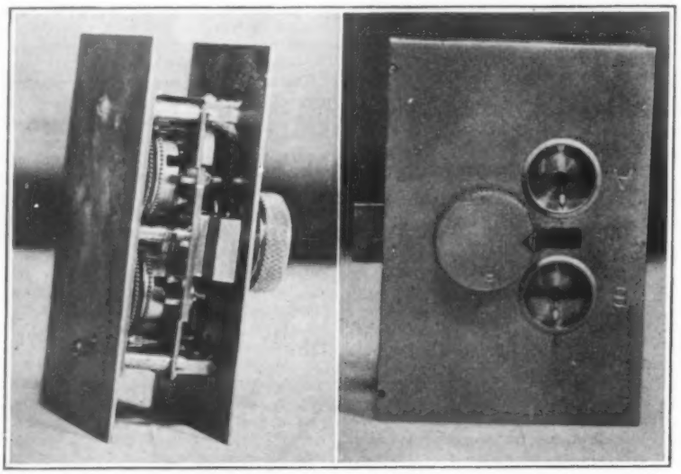
THIS lock differs from all others in its construction and operation; at the same time it is adaptable for general uses. The working of it depends upon the length of time allowed for the mechanism to operate and this is regulated by the individual user. Each mechanism is made of three clock wheels, and is a complete unit in itself, the numbers from 1 to 60, indicated on dials, being controlled by such units. Any one of these numbers may be selected for use, and the operator sets the combination with a key accordingly. When two mechanisms are used, a choice of any one of the numbers of 60 times 60, or 3600, is afforded; three mechanisms enable the operator a choice of 60 times 3600, or 216,000 numbers. Only two mechanisms are necessary to make a practical and efficient working lock, the larger number of mechanisms being more especially adapted for safes and vaults.

One number of each mechanism is selected to be used in operating the lock, such choice being at the option of the individual user, and may be changed at any time, thus precluding the possibility of any person's opening it, other than the one who knows the combination. Either a watch or the indicator hand on the dial may be used for counting the seconds or exact time when the lock will



The presence or absence of lights on this board tells whether the corresponding seats inside are occupied

open. The indicator hand, made of radium and visible in the dark, makes one revolution per second. To operate the lock on the combination of A-7, B-6, turn the indicator to the right so arrow points to A. This allows the mechanism to run seven seconds; then turn indicator immediately to B which allows the mechanism to run six seconds, and the lock is then open. To unlock it, turn the arrow back so it will point to zero. The lock requires no winding, its operation being automatic, and it is made to be used both with and without keys. These mechanisms may be fitted to ordinary key locks, thus making a combination lock of increased efficiency and usefulness. Being operated by clockwork mechanism, all tumblers and noises are eliminated, making it impossible for anyone to know the combination of numbers used and which must be known by the person who opens the lock. The lock can be made any size and is adaptable to all purposes.



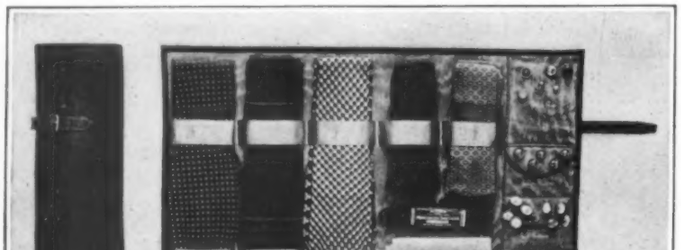
Inside and outside view of the lock in which the time elapsing between the several turns is an element in the combination

A Carrier for Neckties

A GREAT many things have been devised to hold neckties, but few as ingenious as the design shown. At a first glance one would hardly appreciate how very handy this little roll really is and the number of articles it will hold. Here we have nine four-in-hand ties, six bow ties, one-half dozen handkerchiefs, a very neat little pin cushion in the upper righthand corner for the tie pins, etc., and just below that there are four pockets to store away your collar buttons, cuff buttons, shirt studs and other miscellaneous articles to use when needed.

One of the best features of this holder is that when one once places the ties in their proper place they will never need to be disturbed in making the selection of the one desired to be worn. In other words, you can pick out just the tie you want without removing any of the others from their respective places, whether that tie happens to be on the bottom or on the top.

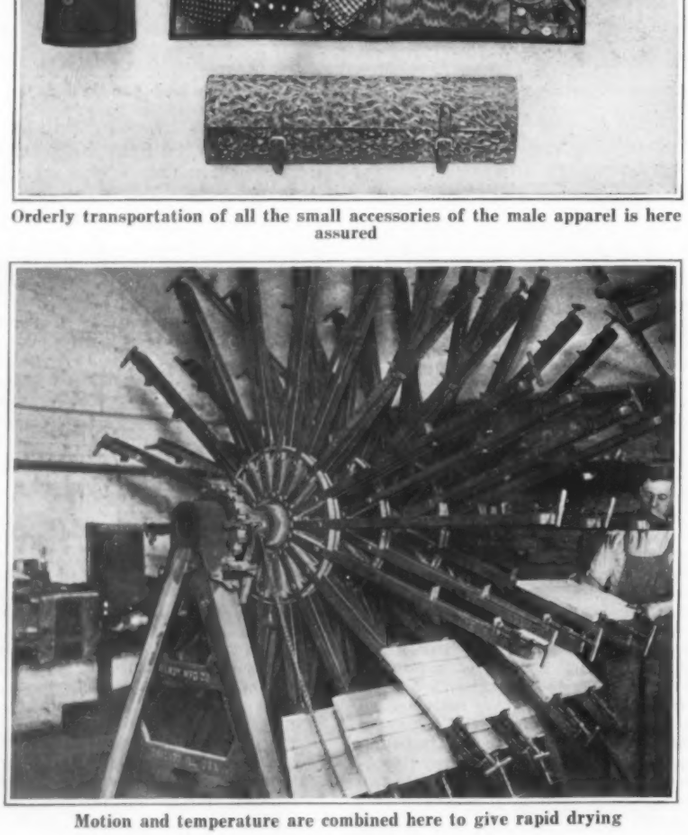
A like invention for the ladies, made up in beautiful fancy leathers, holds two pairs of long gloves, four pairs of short gloves, six veils, a dozen handkerchiefs, hair nets, miscellaneous articles and a divided pocket for various sizes of hair pins, with a pin cushion in the upper righthand corner slightly larger than that on the men's holder for pins, brooches, lavalieres, etc.



Orderly transportation of all the small accessories of the male apparel is here assured

Drying Camera Parts

THIS wheel—or series of wheels—is used for the purpose of drying the glue quickly that holds together the wooden parts of a motion picture camera. The cameras are large, and pieces of wood of sufficient size are difficult to obtain. Hence, recourse has to be had to this method. The workman, after glue has been applied to the proper faces, clamps the parts in place. Heat is artificially applied from below, and the temperature of the room is also high. With the spin of the wheel the glue is dry, and the operator is ready to put in more pieces to undergo the same process.



Motion and temperature are combined here to give rapid drying

News Pictures by Wire in Plain Morse Code

DESPITE the facts that it was not held until 4 p.m., Pacific standard time, and took place nearly 3500 miles away, the Los Angeles *Times* printed, on the morning of the day after the conflict, a correct picture of the Dempsey-Carpentier knockout. There was much interest in this achievement at the time, but it is only now that it is possible to explain how the picture was transmitted. The procedure was simplicity itself, and seems rather to take the wind out of the sails of those who have devised elaborate electrical apparatus for telegraphic transmission of pictures.

A half-tone screen was made by ruling lines on sensitive paper or film, and on this a print of the original photograph was made. The lines were sufficiently close together to make them available as a reference frame for the identification of points on the sheet. This idea is a familiar one, perhaps most often met in connection with the index for a map, where we are told that Metropolisville will be found in section A-6 and Big City in C-13. We all know what this means: we follow the horizontal line labelled A, and the vertical one marked 6, and somewhere in the neighborhood of their intersection we find the little dot that represents Metropolisville.

We could not construct a map from the index, because the lines are too far apart and the instructions given us by the index to locate Metropolisville at A-6 would not be sufficiently definite. But if we draw in the spaces between the two sets of lines, so that we have a very close network with meshes only a few thousandths of an inch wide, we shall eliminate this difficulty, and a map indexed from such a mesh system could be reproduced from the index with a very satisfactory accuracy. That is all there is to the *Times'* system of picture transmission.

The sending operator decides just which lines of the picture are necessary for its proper form. These of course will include all outlines; they will include, in the case of the fight picture, the internal lines that define faces, garments, etc. The operator merely follows these lines with eye or pencil, notes the index numbers of the various line intersections through or close to which it passes, and puts these on the wire. Explanatory remarks are interlarded where it is expected that they may be of aid in the operation of reconstructing the picture at the other end.

As a sample of how the thing works, the *Times* prints part of the message received. The sender was just beginning on the outline of the victor, and so informed the receiver by the first word of this portion of the message: "Dempsey. 26-81¾, 31-83, 33-83¾, 34-84, 35¾-84, 35½-83, 36-82, 37-80, 37¼-99½, 39-79¼, 42-80½, 43-80½, 44-80¾, 45-81, 46-82, 47-83¾, stop. 47¾-83½ . . ." and so on. It will be noted that short cuts are here used rather freely. If no points were to be skipped, it would of course turn out that two successive entries, no matter how great a difference they might show in the horizonal (or vertical) index number, could not display a greater difference than one in the other index number. For every time we cross one of the index lines we define a point which can be coded. But when the despatcher finds a line that runs to all intents and purposes straight from 37¼-99½ to 39-79¼, he begins it simply by naming these two points.

It is plain enough, we think, that with increasing skill in transmission and in interpretation at the receiving end, this system is capable of very good results. The *Times*, when it was able to do so through use of the mails, reprinted its telegraphed picture beside the original. Discrepancies are easy to find; Dempsey is recognizable, but the portrait is a bad one, his head projects too high, his right leg is too thin, the ropes are thin, Carpentier's prostrate form departs from the true figure of the Frenchman as shown on the original, etc. But there could be no slightest doubt that the one is a reproduction of the other, and no reasonable claim that the telegraphed picture did not give a substantially accurate representation of the concluding moments of the big fight. We anticipate a lively future for the new process, especially in view of the fact that on this, the first attempt to use it, the picture was transmitted in fifty minutes, decoded in an hour and ten minutes, and touched up into a finished picture ready for the engraver, by insertion of blacks and whites and shades and high-lights, in an hour more.

Three-Shift System a Failure in British Iron Works

THE three-shift or eight-hour, system has proved a failure in the iron works of the Newcastle (England) district, according to a report of the Board of Conciliation and Arbitration. Instead of promoting increased output without increase of cost, the output has decreased and costs have risen very considerably.

Electric-lamp tester for fast colors

Will Sunlight Fade Them?

HERE is a tester to demonstrate whether certain colors are truly "fast" when they come into conflict with the rays of the sun. Samples of cloth dyed various colors are put into receptacles and exposed to the rays of a powerful lamp that is rich in ultra-violet rays, such as the mercury vapor or arc. If after undergoing the test for fifteen minutes they retain the brightness of their hue, they pass the inspector.

The Traveling Service Station

ONE of San Francisco's large garages has equipped a number of light cars with special oil tanks and a cabinet that carries all kinds of grease and tools. The cars are driven to the customer's place of business and an hour spent in making adjustments, oiling and greasing the car, and testing and filling batteries. This service is given to the regular customers' cars once or twice each month, or oftener if necessary. Each traveling operator serves eight cars daily.

The traveling garage is equipped with two 15-gallon tanks, one for kerosene and the other for carrying cylinder oil. On the back of the car is a cabinet which carries hard-cut grease for filling universals and grease cups; a bucket of fluid grease, with a pump for delivering it; a drain bucket for draining and flushing crank cases; a battery-testing and battery-filling outfit, and compartment for waste. On the inside of the cabinet doors are brackets for oil cans and grease cups. The top of the cabinet is divided into sections for carrying all kinds of tools and wrenches. These sections are covered with a top that is also a creeper, which the operator uses when working under cars.

A bootblack with clean hands!

The Drag of Zeppelin Airships

REPORT No. 117 of the National Advisory Committee for Aeronautics is a discussion of the results of tests with Zeppelin airships, in which the propellers were stopped as quickly as possible while the airship was in full flight. In this paper the author refers to the theory involved in these tests and to one scientifically interesting fact which can be derived from them and which has not yet been noted.

The chief general question concerning these tests is, of course: Does the negative acceleration of an airship with stopped propellers supply proper data for determining the drag of the airship when in uniform flight? This can not absolutely be answered in the affirmative, the two phenomena not being identical in principle. It is believed, however, that in this particular case the agreement is sufficient and that the data obtained from the test are the true or the approximate quantities wanted.

Garage service brought to your door

Door Knob and Bell Combined

BURGLARS and sneak thieves are prone to enter without taking the trouble to knock. A new mechanism, however, corrects this little oversight on their part, if they desire to come in by way of the door. As the knob turns, a lever is operated, communicating with a gong situated a few inches above the knob. The loud peals that issue are guaranteed to give the intruder a hint at least of the wisdom of thinking the matter over, before taking further action.

Shine Them with Electricity

AMONG the novelties exhibited at the recent electrical show in New York was the electrical bootblacking outfit illustrated at the left. The principle is, of course, the same as in many other familiar devices of more or less the same character; the steady patron of the dentist will surely recognize the flexible driving shaft. Like the barber's electrical massage outfit, the electrical shoeshiner is mounted on wheels and is trundled about the floor from station to station. Its cost will probably give the lie to the photographer's enthusiastic caption "the human bootblack will soon be a memory," but at that it will presumably come into wide use.

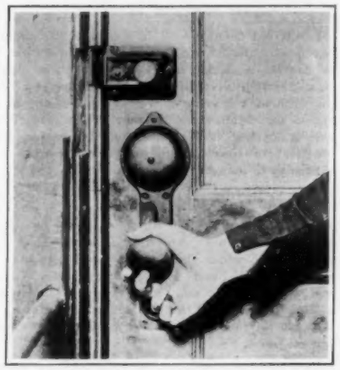
Stresses in Ship Plating

MILD steel plates of rectangular area fixed along their edges or boundaries and subject to uniform fluid pressure are commonly met with in practice. There is, however, a lack of information to guide the designer in assigning dimensions, and the object of a recent paper by Dr. Bernard C. Laws reported in the London *Times* Engineering Supplement was to give some information on this subject.

He pointed out that the plating under the load suffers deflection, in consequence of which direct tension is experienced, affecting the resultant stress not only by virtue of its own value, but by the bending moment which it exerts on the material apart altogether from that resulting from the action of the direct load. At present the determination of stress is possible only by subjecting the plating to experiment and making a mathematical analysis of the derived data. It does not appear that any conclusive experiments have been carried out on stiffened or reinforced plates, and in only a few instances have free plate areas been so treated. Until comparatively recently Grashof's expressions afforded the only aid to designers, but it is realized that the results so obtained are wide of the truth. The author discussed the effect of fluid pressures on the ultimate stress in mild steel plates when considered jointly with the stresses induced in the material on account of local or structural bending of the vessel. He also dealt with the question of stiffened or reinforced plates, and in the absence of complete experimental investigation made an endeavor to trace the effect of the reinforcement in bringing about a redistribution of stress. The subject finds special application in the design of sea-going vessels where the plating forming the skin of the outer or inner bottom and the diaphragm of watertight or oiltight bulkheads is called upon to withstand stresses due to fluid loads in addition to those resulting from bending moments.

A Precision Inclinometer

THE inclinometer has been little known until recently except to those who have had to do with airplanes. The army flyer knows it as one of the instruments on the dash of his plane that indicates whether he is ascending or descending and at what angle, also at what angle his wings are banked for a turn.



Turning the knob rings the bell

An inclinometer has been recently placed on the market designed for use as a precision instrument in mechanical laboratories, machine shops and in building operations. It is a skilfully designed tool consisting of a carefully machined case of cast metal containing an accurately adjusted gear-train driven by gravity impulse. The two dials on the instrument indicate degrees and minutes respectively, the hand on the degree dial moving in unison with the impulse, while the hand on the minute dial is driven by the multiplying gear-train, causing the latter to make thirty-six revolutions while the degree-dial hand makes one revolution. The multiplying effect of the gear train is such that the instrument gives angle readings direct in degrees and minutes with accuracy corresponding to that of a single-dial inclinometer having a dial approximately ten feet in diameter.

A very important and interesting feature of the design of the instrument is the means employed for overcoming the inaccuracy due to bearing friction. This is accomplished by mounting the bearings in rings which are concentric with the pivots and which are connected with arms or levels extending outside the case. The levers are provided with knuried handles and in using the instrument, the operator moves first one handle and then the other up and down a few times, allowing the levers to strike against the ends of the slotted holes in the case. The combination of the hammer effect and the oscillating movement of the bearings around the shafts very quickly eliminates all retarding effect due to bearing friction and the hands of the instrument take a position that gives the true reading.

Reading angles directly in degrees and minutes from the dial

This inclinometer may be used for all purposes where the less accurate spirit level, plumb, or protractor is now employed, and aside from its greater accuracy, is a much more handy tool, as it indicates not only the vertical and horizontal, but all angles in between. For accurate inspection of angles it is a more usable tool than the sine-bar, as the angle is indicated directly, whereas with the sine-bar it is first necessary to set the tool and then go through a series of calculations before the reading is obtained.

Attaching the Stopper to the Bottle

THE bottle and the cork need never be separated if the method shown in the illustration be followed. As will be noted, the device consists of a piece of stout bent wire, one end partly looped about the neck of the bottle, the other thrust through the cork stopper. The looped end slides up and down the smooth glass surface, as required. This simple expedient is worthy of consideration by the chemist, physicist, or the woman who is averse to having her choice perfume spilled, especially on good furniture.

The stopper that stays with its bottle

Recently Patented Inventions

Brief Descriptions of Recently Patented Mechanical and Electrical Devices, Tools, Farm Implements, Etc.

Pertaining to Aeronautics

AEROPLANE WING.—W. E. KNOELL, 609 South 35th St., Tacoma, Wash. The principal object of the invention is to produce an aeroplane having wings supported entirely by wing supports extending from the fuselage, and with said wing supports positioned within the wings in such manner as to obviate the necessity of the use of struts and guy wires. Another object is to construct an aeroplane in such manner that the wing stress incident to flying will be transferred so that the leverage with respect to the fuselage is decreased.

AEROPLANE.—T. A. MACDONALD, 208 Hampton Ave., Paterson, N. J. The purpose of this invention is to provide an aeroplane in which a plurality of planes that normally function as lifting planes are capable of being manipulated to form a parachute for retarding a fall to the ground in the event of an accident, the parachute as a whole being capable of quick adjustment along the fuselage to occupy the most advantageous positions for retarding the fall to the greatest possible degree and of maintaining the machine upright during its gradual downward travel to the earth.

Pertaining to Apparel

GARMENT PROTECTOR.—C. J. KEPPEL, c/o Christian Flag & Novelty Co., Monroeville, Ohio. The invention relates to an article to be worn upon the person as a garment protector and has reference more particularly to a so-called child's bib and sanitary napkin. The primary object is to provide a substantially waterproof article which may be laundered without impairing any of its waterproof qualities and consists of a sheet of waterproof material adapted to be inserted between two sheets of cloth material.

MOCCASIN.—A. F. ORIE, Box 258, Lisbon, Me. The invention relates to foot wear, and has for its object to provide a construction which will be strong and also neat in appearance, while obviating the usual puckered appearance found adjacent the front of a device of this kind. An additional object is to provide a construction wherein the vamp may be formed to extend nearly around the front part of the moccasin or entirely thereover, including the uppers.

Electrical Devices

ELECTRIC BULLETIN.—R. E. JONES, 42nd Inft., Camp Gaillard, Canal Zone, Panama. An object of the invention is to provide an electric bulletin whereby information in the possession of an individual may be disseminated among a large number of persons either by day or night, the characters on the bulletin board in either day or night operation being formed by the manipulation of a transmitter of the same construction.

ARTIFICIAL ILLUMINATION.—G. H. SHERINGHAM, 1 Clanricarde Garden, Bayswater, London, W. 2, England. The particular object of the invention is to provide a means whereby the quality of light derived from an artificial source, such as an ordinary incandescent electric light bulb, may be made to be substantially equal to daylight. The main object is to provide two reflectors, the upper reflector having its reflecting surface colored, and the lower being opaque and reflecting the rays of light on the upper or main reflector, the entire surface of which is covered in small areas with methyl violet, ultramarine, and emerald green.

Of Interest to Farmers

HOPPLE.—E. E. HIGLEY, c/o Iron Creek Farm, Salmon, Idaho. Among the objects of the invention is to provide an animal hopple especially adapted for use with horses, which can be easily applied and removed, only by a person understanding its peculiar features of operation. Another object is to provide a hopple which plays easily around the leg of the animal above the hoof and which will not chafe or bruise.

CLEVIS.—W. PORTER, Route No. 5, Aurora, Oregon. The invention relates to a device used as a draft coupling in agricultural implements, vehicles or the like. An important object is to provide a device which prevents the accumulation of dirt, sand and other foreign matter around the lock joint. Another object is to provide a pin and clevis device which is self-locking, which will not be materially affected by the weather, which will be unlikely to catch on other working parts, and which is easily operated. (See Fig. 1.)

Of General Interest

LOCKING HOOK.—A. L. GEISLER, 29 Summit St., Bristol, R. I. An object of this invention is to provide a device which may function either as a keyring, a coupling link, or a hanger. In the form of a keyring it will prove amusing as a puzzle for children. A further object is to provide a locking hook which will be simple and practical in construction, and comparatively inexpensive to manufacture. (See Fig. 2.)

AIR COOLER.—W. H. STONE, Box 522, Port Angeles, Wash. The invention relates to an apparatus for cooling the air in a house or room during hot weather. An object is to provide a device through which the air is compelled to take a circuitous path and pass through screens over cold water flows, and over saturated moisture-holding pads to cool the air, which finally escapes through an ice chamber and is directed to any desired point.

CLOTHES HANGER AND PRESSER.—MARION G. MCNEELY, Tulare, Calif. The purpose of this invention is the provision of a hanger which is adapted to support men's or women's suits in such manner as to effect a pressing of the skirt or trousers. It is also a purpose to provide a hanger which is adjustable to accommodate trousers and skirts of various lengths and to hold the same under tension to effect pressing. (See Fig. 3.)

WALL CONSTRUCTION.—J. M. NADAL, Humacao, Porto Rico. An object of the invention is to provide a reinforced structure which will greatly reduce the cost of house building. A further object is to provide a construction either of the solid or hollow wall type which will be strong and durable and may be assembled rapidly and cheaply. A further object is to provide a type of panel-shaped building blocks having grooved faces adapted to receive reinforcing rods.

MASK.—F. M. DESSART, 509 Metropolitan Ave., Brooklyn, N. Y. The invention has for its object to provide a mask which includes a body portion adapted to overlie the eyes and nose of the wearer, a sheet of material and a liner affixed to the upper part of the material forming the body portion of the mask, the material being extended beyond the lower edge of the liner and body portion whereby to provide an integral apron.

HOLLOW WALL CONSTRUCTION. — F. HEATH, 1001 McCormick Bldg., Chicago, Ill. Among the objects of the invention is to provide a wall construction in which hollow blocks may be laid horizontally without exposing the voids in the blocks. The object is to provide mitered blocks so formed as to be used at the corners which alternate with blocks disposed vertically, the construction being such that the voids are not only hidden, but the courses are locked together.

ALKALI SALTS OF OXIDIZED PROTALBINIC ACID AND OF OXIDIZED LYSALBINIC ACID AS STABLE PROTECTIVE COLLOIDS FOR MERCURY COMPOUNDS.—DR. MARI. E. WOLVEKAMP, 485 36th St., Oakland, Calif. The foremost object of the invention is to provide pure collodial mercury compounds in the dry state, of which the solutions may be boiled without precipitation of free mercury. The invention relates to the alkali salts of oxidized protalbinic acid and of oxidized lysalbinic acid, obtained out of an albumin from egg albumin, or serum albumin, and their use as compounds for medical purposes.

PIPE COVER.—W. L. GUY, 1206 Lincoln Ave., Alameda, Calif. This invention relates to a smoking pipe in which it is practically impossible for fire to escape or ashes coming from the pipe bowl to get into the user's eyes. The object is to provide a dome-shaped cover capable of being attached to the pipe by means of a ferrule, and having a draft tube extending longitudinally of the axis of the pipe bowl outside of the bowl. The cover may be easily removed for refilling or cleaning of the pipe.

MATERIAL FOR AND PROCESS OF FORMING BRICK TILE AND THE LIKE.—L. JONES, 928 Wheeling Ave., Muncie, Ind. The object of the invention is to provide a material of a nature capable of thorough cementation, under intense pressure, without the necessity of burning in a kiln, as is necessary with clay. A further object is to provide a means whereby a by-product of blast furnace slag may be utilized in forming bricks and tile in various shapes, impractical in a burnt brick on account of the warping and cracking during the burning process. The material contains silica 70 per cent, lime 25 per cent, magnesia 2½ per cent, sulfur 2½ per cent.

BROOM HOLDER.—S. CANTOR, 310 E. 51st St., New York, N. Y. The invention has for its object to provide a holder which is adapted for supporting a double-ended broom which permits the ready insertion or removal of the broom. A further object is to provide a holder of the character stated which can be manufactured and sold at a reasonably low price, which will be strong, and which will securely maintain the broom in operative position.

Hardware and Tools

WATER COOLING CONSTRUCTION FOR WELDING TORCHES.—J. F. GILBERT and T. NEVILLE, P. O. Box 1095, Seward, Territory of Alaska. The primary object of the invention is to provide a water-cooling attachment which may be applied to a conventional type of torch without departing from or materially changing the original construction of the torch. A further object is to construct the water-cooling attachment in such manner that water will be caused to circulate throughout the greater length of the torch, and thus realize effective cooling. (See Fig. 4.)

TOOL.—H. A. WETZSTEIN, 5413 Fourth Ave., Brooklyn, N. Y. The invention has for its object to provide a tool which is primarily designed to facilitate the adjustment of the needle valve on the carbureter of a well-known type of car, in which the needle valve is provided with a threaded stem having a tool-receiving slot in its upper end and a nut around the stem. A further object is to provide a tool which will be capable of simultaneously engaging both the nut and the slot to adjust the valve.

TAPER GRAB.— F. L. CHRONISTER, 618 No. Blvd., Edmond, Okla. Among the objects of this invention is to provide a device of the character specified which may be instantly adjusted for different sizes of wire, rope or cable, and which will firmly grip the rope or cable, but which may be easily released when desired.

TOOL.—R. FAGAN, Box 27, Latimer Mines, Pa. The invention relates to tools used in connection with railroad rails. An object is to provide a tool which is simple and durable, which has a wide range of adjustment, and which permits of the bending of the rail in any one of four directions at any point throughout its length up to and within close proximity of its ends.

SHADE FIXTURE.— W. MCNEALE, Box 351, Greensboro, N. C. The invention has for its object to provide mechanism in connection with shade pictures for permitting the shade to be operated by means constraining the roller and reel to turn together when the reel is turned in one direction, and to disconnect the reel and roller when the reel is turned in the reverse direction.

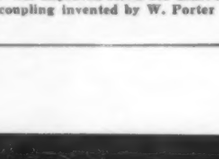


Fig. 1. An improved clevis for draft-animal coupling invented by W. Porter

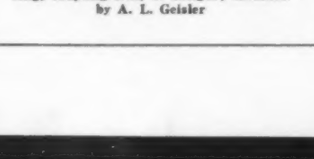


Fig. 2. A locking hook that functions as keyring, coupling link, or hanger; invented by A. L. Geisler

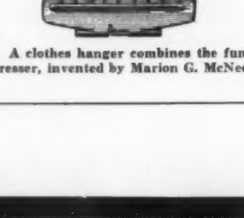


Fig. 3. A clothes hanger combines the functions of presser, invented by Marion G. McNeely

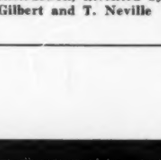


Fig. 4. A water-jacketed welding torch of novel construction, invented by J. F. Gilbert and T. Neville

Fig. 5. The extension rule invented by F. H. Fenwirth, shown in horizontal and vertical section

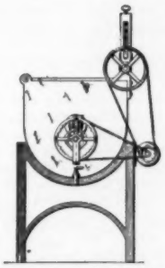


Fig. 6. The specially geared washing machine covered by two patents to F. H. Mayer

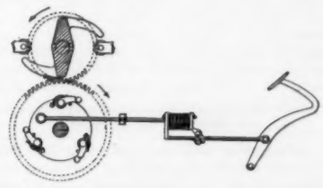


Fig. 7. The automatic, clutch-pedal operated gear-shifting device invented by J. Kirkeby

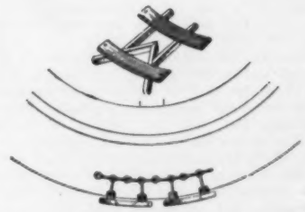


Fig. 8. Anti-skid tire-chain of novel design invented by M. L. Henderson

LOCKING HINGE OR CONNECTION.—F. J. DOWLING, 425 W. 124th St., New York, N. Y. Among the objects of the invention is to provide a hinge or connector, comprising two plates or their equivalent, adapted to be secured to the door and jamb, respectively, and so arranged that whether the hinge pin is used or not they will prevent the movement of the door in any direction with respect to the jamb except the door be first unlocked so that it may be swung or moved in its intended direction.

WRENCH.—A. W. MINNEY, 231 E. Freemont St., Stockton, Calif. An object of this invention is to provide a wrench which is of simple and durable construction, which exerts a proper gripping action upon the work and which immediately responds to the control of the operator during the engaging, gripping and disengaging phases of its operation.

EXTENSION RULE.—F. H. FENWIRTH, 147 W. 126th St., New York, N. Y. The invention has reference more particularly to an extension rule in which the elongation of the rule is obtained by moving the various parallel members composing the rule axially. An object is to provide a rule which is adapted for measuring inside dimensions, and is so calibrated that the distance between inside surfaces may be laid directly on the rule. (See Fig. 5.)

BUTT-HOOK.—C. VALA, Marshfield, Oregon. This invention relates to hooks used for hauling logs when the log is engaged by a wire rope known as the choker. The object is to provide a hook of the character specified which cannot become unfastened accidentally and which is not liable to become fouled with mud, brush and the like, and which may be readily attached and removed.

SOCKET WRENCH.—O. J. WILLIAMS, Orchard Park, N. Y. The invention has for its object to provide a socket wrench having radially adjustable jaws which permit the wrench to accommodate itself to nuts of various sizes. A further object is to provide a readily adjustable mechanism which will be strong and durable, and not readily damaged in the ordinary course of usage.

CONNECTOR LINK FOR CHAINS.—W. A. BROWN, Lincoln, Neb. The invention relates more particularly to separable links for use in connection with tire chains, although not limited to this purpose. The general object is to provide a link of the indicated type with means for locking the swingable elements in closed position, effectively preventing accidental separation.

TRAP.—W. R. LAZENBY, Box 415, Hardin, Mont. The general object of the invention is to provide a steel trap with spring-actuated jaws adapted to clamp the foot of an animal. One of the principal objects is the provision of a trigger member constructed as an independent element which may be loosely attached to the anchor chain, but which is free to fall clear of the jaws as soon as the jaws have been sprung into closed position.

Heating and Lighting

HEAT DEFLECTOR AND DRAFT CREATING DEVICE.—A. J. ANDERSON, 9½ Spencer St., Ashtabula, Ohio. The invention has particular reference to a device to be placed over a burner on a liquid or gaseous fuel cooking stove to concentrate and intensify the flame. An object is to provide a device which is so constructed that the passage of flame will create a suction, drawing up air between the burner and the device, while air commingles with the flame and is conducted upwardly in the form of a concentrated intensified flame of great heat value.

STEAM CONDENSER FOR CLOTHES PRESSES.—J. BUFF, 317 Summit Ave., Jersey City, N. J. A purpose of the invention is to provide an apparatus to be installed upon any standard type of steam clothes press, and used with the press for the purpose of collecting the exhaust steam. A further purpose is to provide means for collecting the cold water condensation which forms in the pipe and again utilize it within the press boiler to prevent waste, and to prevent the hot steam from passing into the room.

METHOD AND APPARATUS FOR PRODUCING A REGULAR PROGRESSION OF MATERIALS IN VERTICAL OVENS.—J. PIETERS, 12 Rue de la Rochefoucauld, Paris, France. The invention relates to a previous patent granted to the same inventor, which consists of the use of a coke pusher traveling above the ovens to allow of exerting a very considerable pressure upon the upper portion of the coil. By the present improvement the material is compressed and forced to travel through the ovens and to be discharged therefrom, thereby permitting continuous vertical ovens to be discharged with at least as much ease as the discharging of ordinary discontinuous horizontal ovens, at the same time preventing the escape of gas.

TUBE CLEANING APPARATUS.—J. H. WHITE and E. J. FRANKLIN, Hayden, Arizona. The invention particularly relates to an apparatus for removing scale, sludge or incrustants from the tubes or pipes of surface condensers, boilers, heaters, evaporators, coolers and like devices. An object is to provide means whereby either liquid, semi-liquid, or particles of solid matter are drawn through the tubes by suction or partial vacuum to effectually clean the interior of the tubes without damaging the same.

HOT AIR REGISTER.—J. L. ELLISTON, Clinton, Mo.—An object of this invention is to provide a register adapted for use in connection with the so-called pipeless furnaces, the register having means for cutting off the view of the interior of the main conduit of the furnace from the room into which the conduit discharges, and in addition to cutting off the view give the register an appearance of strength.

Machines and Mechanical Devices

NAIL DRIVING AND SETTING MACHINE.—A. RIVER, 323 44th St., Brooklyn, N. Y. An object of the invention is to provide a manually operable machine for handling parquet nails, such as are commonly used in laying floors, and to provide means associated with the machine for automatically feeding the nails. A further object is to provide a machine which accomplishes the driving and setting operation at the same time, and which is, therefore, a great time-saver.

PUMPING DEVICE.—G. K. LIGHT, 369 Gates Ave., Brooklyn, N. Y. The invention particularly refers to a simple and efficiently operated pump of the rotating type. An object is to provide a device which in a simple manner causes a constant flow of liquid through the pump as a result of an application of the centrifugal action taking place in the rotating receptacle. The pump requires a minimum amount of power, and is composed of a small number of parts.

COLLAPSIBLE CORE AND CHUCK.—P. DE MATTIA, Clifton, N. J. This invention relates to collapsible cores and chucks for use in the manufacture of pneumatic tires. Its object is to produce a core and chuck so constructed that while affording an effective support for the tire while building up the carcass and the fabric into tire shape, it will permit ready disengagement of the built-up tire from the core with a minimum effort on the part of the operator and with a minimum distortion of the tire.

WASHING MACHINE AND GEARING FOR SAME.—F. H. MAYER, 254 Elate St., Denver, Colo. The inventor has been granted two patents relating to the same subject matter, one has for its object to provide a washing machine with a clothes cradle made of strong wire mesh but given a corrugated shape to produce a wash-board effect; the cradle has no interior rods or projections which would tend to cause the clothes to become entangled. The other invention provides for a mutilated drive gearing for oscillating the clothes cradle so as to wash the clothes and a continuous gear for revolving the cradle to expel the water therefrom. (See Fig. 6.)

BOX GLUING APPARATUS.—O. A. LUCAS, Richwood, W. Va. The invention relates to an apparatus for the gluing of pasteboard boxes, and has for an object the gluing in place of the covers of the boxes which, after being placed on a platform, are held in engagement until the glue is dry. The apparatus is adapted to operate on boxes of various sizes.

Medical Devices

DOUBLE CURRENT SYRINGE.—J. K. MITCHELL, 921 Coward Place, Memphis, Tenn. This invention has for its object to provide a device of the character specified by means of which thorough irrigation may be had, with thorough drainage, and wherein, with the syringe in place in the cavity, the irrigating solution may be permitted to waste, or may be directed into the cavity through the spray head.

Prime Movers and Their Accessories

PROCESS AND APPARATUS FOR IMPROVING COMBUSTION IN EXPLOSIVE ENGINES.—W. W. HALES and A. HINE, 100 William St., New York, N. Y. An object of the invention is to utilize the large quantity of heat represented by carbon monoxide in the exhaust gases of an internal combustion engine, by introducing ozonized oxygen, or ozone along with the explosive mixture of fuel since ozone is a much more active oxidizing agent than atmospheric oxygen and therefore all the carbon monoxide will be completely burned to carbon dioxide with a result of increasing efficiency of the engine. The introduction of ozone will also prevent the formation of elementary carbon on the walls of the cylinders, the piston, and the spark plug.

SPARK PLUG.—R. W. MOORE, 706 Rialto Bldg., St. Louis, Mo. An object of the invention is to provide a spark plug for internal combustion engines which may be quickly and conveniently cleaned without the use of tools, while the same is installed upon the cylinder of the engine, and without separating the elements of the spark plugs.

FUEL HEATER FOR INTERNAL COMBUSTION ENGINES.—L. A. COUCH, 530 W. 136th St., New York, N. Y. The foremost object of the invention is to provide a simple electrically operated fuel heater, which consists principally of a wire resistance disposed across the current of carbureted air for the purpose of heating this air before it enters the intake manifold. A further object is to provide an electric resistance the wires of which are so fine that the flow of air will not be impeded.

Railways and Their Accessories

SUPERHEATER.—W. G. LANDON, 60 Broadway, New York, N. Y. An object of the invention is to provide a superheater for locomotive boilers and the like, in which the steam-carrying elements are located in the fire box above the brick arch and connected with headers outside of the boilers and provided with automatic damper controlling mechanism which admits air to the space occupied by the superheater when the throttle is closed and the steam-carrying elements are empty, to prevent injury to the elements by the heat of the fire box.

SAFETY BRUSH BRAKE FOR RAILROAD MOTOR CARS.—S. C. TANNER, Relay, Md. The invention relates more particularly to cars utilized for various purposes, including the inspection of railway lines, the invention being applicable alike to manually propelled cars as well as gasolene cars, which are of light weight as compared to other railway rolling stock, and easily derailed by stones and other small articles. The device may be utilized to clear the tracks of small obstructions, and may be used as a brake when stopping the car.

Pertaining to Recreation

TOY RAILWAY.—C. F. EDWARDS, 36 Waverly St., Ottawa, Ontario, Canada. Primarily the invention aims to simplify the commercial manufacture of miniature toy railways, whereby to permit of a substantial reduction in size without weakening or detracting from the durability or attractiveness of the toy, and to overcome the common tendency of the cars to jump the track by providing a form of supporting wheels, and a roadbed with which the same will coact.

Pertaining to Vehicles

ANTISKID DEVICE.—O. S. PULLIAM, 29th floor, Singer Bldg., New York, N. Y. The primary object of the invention is to provide a device for use with wheels of motor vehicles, which is permanently attached to the wheel and is movable into and out of operative position with the tire or traction surface of the wheel. Another object is to provide means by which the traction increasing elements are locked against movement in both their operative and inoperative positions. The device may be used with pneumatic tires without injury to the tire in any way.

TRANSMISSION.—O. S. PULLIAM, 29th floor, Singer Bldg., New York, N. Y. The invention relates more particularly to a driving mechanism for vehicles of the self-propelled type. The primary object is to provide a driving mechanism for motor vehicles in which various speeds may be obtained without the use of the transmission mechanism commonly employed. A further object is to provide means for supporting the propeller shaft in such a manner as to permit of the foregoing operation.

AUTOMATIC GEAR-SHIFTING DEVICE.—J. KIRKEBY, 1143 Sycamore St., San Luis Obispo, Calif. The invention is designed more particularly for use with automobiles of the class using sliding gear speed changing transmission, its principal object is to provide means whereby a predetermined change can be made by the action of the clutch pedal controlled by a dial or the like. Another object is to replace the shifting lever now in use with a mechanism connecting directly with the shifting rods, or forks where the shifting rods are incorporated in the cover of the transmission. (See Fig. 7.)

DIRECTION INDICATOR FOR MOTOR VEHICLES.—T. A. BRETT, Pittsburg, Calif. An object of the invention is to provide a means by which the driver of a motor-driven vehicle can conveniently indicate to the driver of any other vehicle traveling in the same or opposite direction the fact that he wishes to stop or turn to the left or right. The device indicates the course to be pursued in front as well as in the rear, the device being actuated by simple mechanical means.

TIRE CHAIN.—M. L. HENDERSON, c/o Old Faithful Ranch, Moore, Mont. The invention has for its object to provide a chain which is easily applied and detached, and will hold the wheel from slipping in any direction. The chain is composed of a series of links, each of which consists of a pair of plates spaced apart from each other and adapted to extend transversely of the tire and connected by an open framework of cleat bars, whereby the tire will not be injured as a result of continued use. (See Fig. 8.)

TRACTION WHEEL.—G. H. SCANLAN, 202 Fulton St., New York, N. Y. The invention relates to a wheel capable of use on tractors or other power devices and vehicles, and has for its object the provision of a construction wherein a comparatively wide and long base is provided at all times so as to support the parts on comparatively soft ground. Another object is to provide a wheel which utilizes pivotally mounted shoes and means for holding the shoes in position so as to engage and also leave the ground readily.

Pertaining to Aeronautics

DEVICE FOR COOLING THE MOTORS OF AIRPLANES OR DIRIGIBLE AIRCRAFT.—H. R. GUYOT, 54 Avenue Jean Jaures, Paris, France. The invention relates to a cooling device, the arrangement of which effects in a simple and certain manner the internal ventilation of the shell or casing of the apparatus used for aerial navigation, airplanes, dirigible balloons, etc., and also effects the perfect cooling of the motors for such apparatus, by permitting the utilization of the direct action of the speed of the airplane to cause the hot air inclosed in the chamber of the motor to circulate.

Pertaining to Apparel

SOFT COLLAR FASTENER.—L. REITER, c/o Rau Fastener Co., Providence, R. I. The object of this invention is to provide a collar fastening device which combines with clamping means small spurs which function to engage the inner side of the collar wings and anchor the device to the collar without tearing or otherwise defacing the outer surface thereof. A further object is to provide a fastener which is easily associated with or removed from the collar.

Electrical Devices

STEAM WALLPAPER REMOVER.—A. W. TUCKER, c/o Tulsa Hotel, Tulsa, Okla. The object of the invention is to provide a steam wallpaper remover which is self-contained and of simple and unitary construction which electrically generates its own steam in a convenient and entirely safe manner, which applies the steam to the wallpaper so that the steam permeates, softens and loosens the same to effect the complete removal thereof.

PNEUMATO-ELECTRIC SWITCH FOR MUSICAL INSTRUMENTS AND THE LIKE.—A. H. WILLIAMS, 2817 W. 44th St., Minneapolis, Minn. The foremost object of this invention is to provide a pneumato-electric switch to be used in operating musical instruments such as organs, pianos and the like. The device is not limited to the application to organs having no keys, but is also adapted to instruments having a pneumatic player action.

LAMP.—G. E. VILLARET, 1652 University Ave., New York, N. Y. The invention relates more particularly to electric lamps, an object being to provide a lamp which employs but a single electric bulb and which functions to illuminate the room as well as give forth a diffused light for reading. A further object is to provide a table lamp in which the light from an incandescent bulb is deflected upwardly to illuminate the room and diffused downwardly to prevent glare to the eyes of those seated.

HEATER.—L. A. TACTIKOS, 416 Greenwich Ave., Greenwich, Conn. One of the principal objects of the invention is to provide an electrical heater especially designed for warming confection batches, the same including means for regulating the degree of heat and controlling the projection of the heat rays to concentrate them upon the batch while working the same. A further object is to provide a portable heater which is simple and inexpensive.

ELECTRIC RAZOR.—J. A. HAMMOND, 210 So. Granite St., Deming, New Mexico. Among the foremost objects of the invention is to provide a concave razor of the ordinary straight blade type, with electrically operated means for giving the blade a swinging cutting stroke in contradistinction to the parallel or "chopping" stroke which is characteristic of electric razors in common use. A further object is to provide a razor wherein the operating mechanism is so incased in the handle as to present a graceful appearance.

AUTOMATIC CALL SYSTEM FOR HOTELS.—A. H. HEYBOTH, address H. W. Coulter, care U. S. Electric Products Corp., Duluth, Minn. An object is to provide a call system which may be readily applied to an ordinary telephone system so that the same circuit wires can be used for the two purposes. A further object is to provide a system which embodies a master clock, whereby the call apparatus may be set for calling the guests at predetermined times, and whereby the called guests can cut off the signal, or whereby the guest can signal to the clerk.

CIRCUIT CONTROLLING TELEPHONE RECEIVER SUPPORT.—J. B. FURBER, Union Bldg., Newark, N. J. This invention relates to desk telephones. The object is to control the switch mechanism by an extensible receiver support of the lazy tongs type and carrying a receiver at its outer end, the receiver support when in folded position opening the telephone circuit and when moved into extended position closing the circuit for the transmission of messages.

FLASHLIGHT.—J. VINCE, 429 78th St., Brooklyn, N. Y. The invention particularly relates to a portable flashlight in which conductor means is provided, associated with the battery and independent of the shell to be insertible and removable with the battery, as distinguished from a conductor strip on the shell at the interior and which is likely to be damaged by removal of the battery especially when the latter "freezes" to the shell.

Of Interest to Farmers

APPARATUS FOR TILLING THE SOIL.—C. C. COOK, c/o Rividge Land & Navigation Co., Stockton, Calif. The invention has reference more particularly to an apparatus which has a rotating element adapted to dig a trench, cut up vegetable growth, and then return the soil to the trench. An object is to provide an apparatus in which the weeds, cornstalks and the like are first pressed flat to the ground, are then cut into pieces, a trench dug, and the loose soil from the trench with the fragments again thrown back into the trench.

CALF WEANER.—F. SCHMIDT, Swanwick, Ill. This invention has for its object to provide a device which is of extremely simple and light weight construction, and easy and inexpensive to manufacture and which will not work injury to the animal and is entirely humane in all respects, although effective in use. The device, which is in the form of an aluminum mouth-plate, is supported by the nostrils of the animal.

ATTACHMENT FOR TRACTOR WHEELS.—E. L. POLANSKY, R. No. 1, Box 6, Munden, Kans. Among the objects of the invention is to provide an attachment adapted for tractor wheels of any character, as, for instance, binders and the like, wherein the wheel carries a series of cleats or spurs capable of being extended beyond the rim of the wheel, and normally spring held in retracted position, with means operable from a distance, for moving the cleats into operative position at any part of the wheel which is engaging the ground.

KICKING BOOT.—W. NELSON, R.F.D. No. 2, Walcott, N. Y. An object of the invention is to provide a device which can be readily secured to the hind leg of a cow to prevent kicking. A further object is to provide a boot comprising a splint extending across the joint and at the front of the rear leg of the cow and provided with an arrangement of straps which are passed around the rear of the joint and secured to effectually maintain the shield or splint in position to prevent the use of the leg for kicking.

Of General Interest

TWINE HOLDER.—W. and W. A. CRABTREE, 1726 Highland Ave., Portsmouth, Ohio. The invention has for its object to provide a holder wherein bags of various sizes may be stored to be withdrawn when desired for use, wherein practically all the space within the holder is utilized to the best possible advantage, and wherein both twine and the various sizes of bags are accessible from either side of the holder.

SPRAYING NOZZLE.—W. LANGE, Tannersville, Pa. This inventor has been granted two patents of a similar nature, the object being to provide a spraying nozzle designed for use in connection with refrigerating apparatus and the like and arranged to insure a thorough spraying of the hot water or other liquid into the air to effect a rapid cooling of the water for re-use in the apparatus. Another object is to permit of readily adjusting the nozzle with a view to spraying the liquid in either fine or coarse mist, and to provide a nozzle which is very simple and not liable to get out of order.

FLUE SCRAPER.—E. ABER, 216 State St., St. Joseph, Mich. This invention relates to the flue scrapers of the kind used in connection with boiler flues. The general purpose is to provide a scraper having interchangeable parts, many of them alike, and thus admitting of standardization, the various parts being so arranged that in the complete device they constitute a scraper having considerable flexibility and adaptability, together with a high degree of efficiency.

POCKETBOOK AND THE LIKE.—L. LANGLEB, 1981 La Fontain Ave., Bronx, N. Y. Among the objects of the invention is the provision of a construction wherein the usual folding or accordion effect is produced at the ends of the pocketbook while the amount of high-priced leather is reduced. Another object is to provide a pocketbook of substantially the usual appearance, but with folded end members independent of the center or body part.

CONVERTIBLE FURNITURE.—T. HANLEY, East Norfolk, Mass. The object of the invention is to provide a piece of furniture of the character specified, which may be quickly and easily converted into a sofa, into a crib having side and end walls, or into a couch bed, and which when in normal position will be ornamental, and will differ but slightly from the usual type of sofa or settee.

ATTACHMENT FOR CHILDREN'S CARRIAGES.—F. PETERS, 101 14th Ave., Astoria, L. I., N. Y. The primary object of this invention is to provide an auxiliary seat for children's carriages which is adapted to be readily attached to the carriage and move therewith. It is a further object to so construct the device that the carriage to which it is attached will not be subjected to undue strain due to the carrying of the extra passenger.

CALENDAR.—A. J. MCDADE, 416 N. Y. World Bldg., New York. The general object of the invention is to provide a perpetual calendar of the type in which separate adjustable means are provided for displaying, respectively, a day of the month, the name of the week-day, and the name of the month, and notably with respect to the means for displaying the day of the month prominently.

PRICE TAG HOLDER.—A. H. NEWTON, 947 Reliance St., Beaumont, Texas. This invention has for its object to provide a device of the character specified adapted for connection with the hangers of garments for carrying a tag with data thereon concerning the garment carried by the hanger, and which may be easily attached to the hanger.

BED SPRING AND AUTO CUSHION.—A. F. STURM, Nehawka, Neb. Among the objects of the invention is to provide a supporting spring arranged to obtain a maximum of resiliency and cushioning effect, and wherein means are provided in connection with the main spring, in the form of auxiliary springs at the top of the main spring, for holding the main springs in proper relation with respect to each other while at the same time permitting them to yield laterally.

ELASTIC AUTOMATIC ADJUSTABLE BLASTING SHELL.—R. L. BOWMAN, R. F. D. No. 5, Knoxville, Tenn. The invention relates to shells for blasting in coal mines, rock quarries and the like. The object is to provide a shell of such character that all the requirements of the coal miner or other user are met, and whereby any differences in the size or depth of holes or the amount of powder needed for a certain shot are automatically arranged for in the construction of the shell.

MEDICAL COMPOUND.—J. H. MCDAVIS, 636 E. 42nd St., Chicago, Ill. The object of this invention is to provide a compound especially adapted for use in the treatment of neuralgia, to be used externally. The compound is composed of the following ingredients: black gun-powder, chloroform, beef-gall, and alcohol. The compound may be used in the same manner as a liniment on any part of the body.

PENCIL ATTACHMENT.—E. W. OWEN, 515 W. 41st St., New York, N. Y. This invention relates to attachments for pens and pencils and pertains particularly to a device adapted to support one end of the pen or pencil to which it is attached out of contact with the desk or table upon which the pen or pencil may rest. The primary object is to construct a device which may be attached without changing the construction of the pen or pencil.

PORTABLE HOUSE.—M. BLAI, 1854 W. 21st St. Place, Chicago, Ill. An object of the invention is to provide a portable building which when assembled does not look like a portable building but like a building of regular construction, by joining the different units together in such manner that the joints are not noticed. The units are designed to interlock one with the other, so there is necessitated very little bolting of the different sections which may be quickly assembled, and the inner and outer walls provide a dead air space.

PIN TICKET.—C. F. WHITE, 526 W. 211th St., New York, N. Y. Among the objects of the invention is to provide a ticket which may be applied to a garment in such manner that it is necessary to destroy the ticket in order to remove the same; a further object is to provide a ticket in which the pointed ends of the pins are concealed and covered so that one handling the garment is in no danger of scratching his hands.

COMBINED ANKLE STRAP AND ARCH SUPPORT.—A. POSNER, 149 Roebling St., Brooklyn, N. Y. The invention relates to supports for use as an insert in shoes arranged to simultaneously hold up the arch and brace the ankle, and to prevent the foot from moving within the shoe thereby giving the desired comfort to the wearer especially when walking. An object is to combine an ankle stay and arch support into a single unitary structure.

TANK.—J. E. FLITCROFT, address K-T Mfg. Co., 911 1st Ave., Asbury Park, N. J. The invention is primarily intended for use in connection with a blow-torch by means of which the fuel will at all times be fed to the burner as long as any appreciable amount remains in the tank, a further object being the provision of an adjustable supporting member which will permit of the burner nozzle assuming an inclined position without danger of the tank overturning.

ARTIFICIAL HEDGE, LAWN AND SIMILAR ARTICLE.—R. W. TULLY, Brunton Studios, Hollywood, Cal. The object of the invention is to provide an artificial hedge, lawn or similar article for use in stage settings or for camouflage purposes. Another object is to provide an exceedingly strong and durable structure which can be readily moved about. Another object is to permit of the manufacture of the article at a comparatively low cost.

METHOD OF CASTING.—W. LEAHY, 509 E. 77th St., New York, N. Y. The invention relates to a method of casting whereby a metallic member in the process of being formed is rigidly secured to an already formed member, the connection embodying strength and firm gripping qualities, so that the one member would not eventually become detached from the other. It is primarily intended for use upon high class receptacles such as casseroles, etc.

INSECTICIDE.—A. CONSTANTIN, 616 E. 17th St., New York, N. Y. This insecticide is especially valuable in the extermination of bedbugs and other house pests. The object of the invention is to provide an insecticide which is highly poisonous to insects, and when placed in an infected region will remain in place for long periods of time without being blown away or becoming detrimental to the health of human beings. The ingredients are as follows: Lard 8 parts, soap 1 part, yellow paint powder 1 part, and green paint powder 1 part.

TOOTHBRUSH.—C. E. CARROLL, Newport, Texas. The invention relates more particularly to the double-headed type of brush adapted to clean both sides of the teeth and the margins of the gums at the same time. An object is to provide a construction wherein a slight rotary motion of the two halves of the brush may be effected to bring the pressure on the tips along the gum margins, where perfect cleansing is most to be desired.

CHECK PROTECTOR.—J. J. O'BRIEN, address Seward Shanahan, 44 Court St., Brooklyn, N. Y. The invention aims to provide a check protector which will primarily be of such a simple construction as to permit of its being placed upon the market at a nominal figure. A further object is the construction of a device which shall be extremely light and compact so that it may be carried in the pocket, that a check may be marked to prevent the amount being raised or the written matter otherwise altered.

COPY HOLDER.—A. N. WOODRUFF, 461 Hudson St., New York, N. Y. The invention pertains more particularly to a device for supporting in a visual position stenographers' note-books or other copy. It is the primary object to provide a copy-holder, with a marker movable with respect to the copy carried, and means by which the movement of the marker may be adjusted to steps of various lengths.

NON-SLIP DEVICE.—J. G. ZERTUCHE, address Ruben Zertuche, 535 W. 112th St., New York, N. Y. The invention relates to a device comprising a suction cup which when in use is secured to an article of footwear for man or horses, the cup being sustained inverted in a manner to present its open side to the ground for collapsing under imposed pressure and effecting a holding action on the ground to prevent slipping, said cup having a vent opening automatically, closing under pressure and opening when the pressure is released.

ALLOY.—H. HECHT, 1448 West Farms Road, Bronx, N. Y. An object of the invention is to produce an alloy capable of taking a high polish, having a high tensile strength and elasticity, which is non-corrodible and impervious to the action of cold, dilute or concentrated acids, such as sulfuric, tartaric, citric, oleic, oxalic, formic, as well as alkalis, sea water, and atmospheric influences. The alloy contains copper 25-40 per cent, nickel 20-40 per cent, chromium 6-12 per cent and iron 25-40 per cent.

LEAK-PROOF JOINT.—H. W. WERELEY, 82 W. 39th St., Bayonne, N. J. The invention relates to covers for manholes, heads of boilers, stills and other apparatus. The object is to provide a leak-proof joint arranged to compensate for expansion and contraction due to variation in heat and pressure. Another object is to provide a leak-proof joint arranged to permit of convenient assembling or disassembling.

EXTENSION TABLE.—J. HERMANS, c/o Miller & Wilkinson, Attorneys, U. S. National Bank Bldg., Vancouver, Wash. Among the objects of the invention is to provide an extension table, and more particularly a table having a permanent

series of lapping leaves capable of extension and contraction in such a way as to avoid the necessity of inserting leaves within and removing the same from their proper places in tables as at present used.

BROOM.—S. CANTOR, 310 E. 51st St., New York, N. Y. The invention more particularly relates to double-ended brooms which are capable of reversal so that both ends may be used and thus result in economy to the user. An object is to provide a double-ended broom having an arrangement of corn or straw whereby the smaller ends are at the outer end of the broom, and the thicker ends at the intermediate portion, where they are clamped together and contracted to give the desired flare at both ends.

Machines and Mechanical Devices

AUTOMATIC GAGE.—O. DEL. BRAINARD, 210 Second St. No., Great Falls, Mont. This invention relates more particularly to gages designed to be used on linotype saws, an object being to eliminate as far as possible the necessity of hand work in spacing matter to fit ruled book headings and the like. A further object is to provide a gage which can be used in connection with any ordinary type of linotype saw, and give more accuracy than is possible under ordinary methods.

DEEP WELL PUMP.—S. CASSIBA, 319 New York Ave., Brooklyn, N. Y. The invention has for its object to provide a construction for pumping liquids from great depths or to great heights. A further object is to provide a pumping apparatus in which the lifting medium is compressed air, with the parts so arranged that a comparatively low pressure and large vacuum will operate to lift the liquid to any desired height from a low altitude to a high altitude.

TEXTILE-FABRIC TREATING MACHINE.—L. CLARENBACH, 159 Hamilton Ave., Passaic, N. J. The invention relates to machine for treating in liquids textile fabrics in open width or in the form of strings or ropes and has for one of its objects to provide a construction wherein dyeing and scouring and other treating of the fabric may be carried on rapidly and uniformly. Another object is to cause the treating liquid to quickly and evenly penetrate the fabric.

FLOTATION MACHINE.—L. D. LYONS and C. F. HOFF, 55 Missoula Ave., Butte, Mont. The invention has particular reference to the recovery of valuable minerals from their crushed ores, the object being to provide a machine which is equipped with floating froth gutters and an automatically controlled weir gate. The process is especially adapted for minerals of the sulfid type, where the preferential action of the air bubbles on the valuable minerals contained in the pulp is especially marked and causes a very complete separation.

FIBER EXTRACTING MACHINE.—W. O. LAMBERT and G. H. POUND, 701 Texas St., El Paso, Texas. The invention more particularly relates to that class of machine employed in connection with the separation of fiber from "agave" and other vegetable matter and leaves, for use in the manufacture of rope and cordage. One of the primary objects of the invention is to produce a machine which will adequately treat both sides of the agave leaf or other plant to insure the positive removal of all pulpy matter from the fiber so that the fiber will be thoroughly cleansed and in marketable condition.

DRILL HEAD FOR WELL DRILLING APPARATUS.—S. C. GILTHORPE, 4517 Chestnut St., New Orleans, La. An object of the invention is to provide a well drilling apparatus for oil or gas wells which includes means for constantly playing streams of water on the cutting elements in order to minimize the danger of fire which might be generated by sparks due to contact of said elements with rocks or other solid substances. A further object is to provide a drill head which is insertible through and removable from a well casing without the necessity of removing the casing.

PISTON RING.—W. D. MATHEWS, Marlette, Mich. The object of the invention is to provide a ring which will be proof against leakage in every direction. The piston ring comprises two similar sections, each having a diagonal gap, the gaps being opposite in the assembled ring, each circular section including an outwardly extending flange having its greatest thickness opposite the gap of the other section and tapering gradually toward both ends, the ends terminating short of the gap, and an inwardly extending radial pin on each section, the sections being recessed for the accommodation of the pin.

COMBINED PRESSURE REGULATING AND GOVERNING APPARATUS.—J. P. METZGER, c/o The Leslie Co., Lyndhurst, N. J. The invention has for its object to provide a fluid pressure regulator in which a diaphragm controls the action of a main valve arranged to maintain a predetermined pressure of the fluid passing through the regulator irrespective of boiler or initial pressure. Another object is to allow the regulator to deliver steam or other fluid to an engine, for instance, at a predetermined pressure.

MACHINE ELEMENT.—G. C. WEISS, Box 148, Oakland, Cal. The general object of the invention is to provide a combination of machine elements; it has reference more particularly to a mechanical movement for realizing a so-called compound tumbling or revolving motion. The invention is so constructed that it may be used in various devices, for instance, in washing machines, concrete mixers, churns, and different kinds of tumblers.

BOTTLE CAPPING MACHINE.—G. C. and W. F. ADAMS, 3852 19th St., San Francisco, Calif. The object of the invention is to provide an inexpensive and simple device by which crimped caps or corks may be firmly pressed on bottles so as to make a good air-tight connection. The bottle to be capped is placed below a plunger and the cap interposed. A pressure on a lever will cause the plunger head to firmly press the cap over and around the top of the bottle.

DISH WASHER.—A. H. HOCK, 31 Rogers St., Bluefield, W. Va. The invention has for its object to provide a device especially adapted for family use, wherein a container is provided for the water, and a second perforated container for the dishes, and having means for rapidly oscillating the same for forcibly driving the water through the perforated walls of the inner containers, and means for limiting the movement of the dishes with respect to the oscillating container.

Prime Movers and Their Accessories

SPARK PLUG.—J. S. COYLE, 336 University Club Bldg., St. Louis, Mo. The primary object of the invention is to provide a spark plug in which the terminals are movable with respect to one another to prevent the accumulation of soot and carbon thereon. It is a further object to construct the device in such manner that the electrodes are movable with respect to each other by means of the piston of an internal combustion motor.

Railways and Their Accessories

CIRCUIT CONTROLLER FOR TRAIN CONTROL APPARATUS.—J. G. FISHER, McLean, Va. A purpose of the invention is to provide a circuit controller comprising a contact wheel, a rockable rail, and means urging the rail toward the contact wheel to produce a scraping contact as the wheel passes, thereby effecting the removal of foreign matter, such as snow or ice, from the contacting surface to insure a good electrical contact.

GREASE CUP.—T. C. DAVENPORT, 240 Lombard St., New Haven, Conn. The invention relates to grease cups more particularly adapted for use on locomotive side rods. An object is to provide a grease cup in which, after the engine is running, the grease will warm and flow, but the cup will not become lost due to the vibration or motion of the side rod.

SAFETY SCALE-PROOF AUTOMATIC GAGE COCK.—L. WHIPPLE and Z. ONEAL; address J. Oneal, c/o H. & S. Freight Office, Shreveport, La. This invention has special reference to that class of gage cocks using multiple valves and which are adapted to be used in connection with locomotive boilers. An object is to provide a separable gage cock to admit of the main valve and stem being removed for regrinding and other repairs without removing the entire assembly from the boiler, or withdrawing the steam.

RAIL LUBRICATOR NOZZLE.—J. M. RIDDLE, Alamogordo, N. M. The invention relates to railway track lubricators and has reference more particularly to a rail lubricator nozzle of elliptical shape provided with spreaders so arranged as to insure the proper spraying of the rail with water when the railway car is rounding a sharp curve, thus presenting a clean track for the cars which follow the locomotive.

Pertaining to Recreation

STEEL FISHING ROD.—H. E. RAWSON, 536 Lake Shore Drive, Chicago, Ill. Among the objects of the invention is to provide a steel fishing rod comprising a plurality of sections of various lengths relatively arranged in such a manner that the weight and resistance in a rod of given size are distributed to afford the desired flexibility and balance, with ease of handling.

TOY BUILDING BLOCK.—W. S. SHIELDS, R. F. D. No. 1, Yardly, Pa. This inventor has been granted two patents of a similar nature. Both relate to toy building blocks, and have for their object to provide a block by means of which many different articles may be constructed, merely by connecting the blocks with each other, as, for instance, building vehicles, aerial and marine, as well as many different devices without the necessity of any means other than the blocks themselves for making the connection. All the tongues and bars of the blocks are flexible, and the arrangement permits the dove-tailing of the blocks together.

Pertaining to Vehicles

DIRECTION INDICATOR. — M. T. MCINTYRE, c/o Gooch Milling Co., Lincoln, Neb. The primary object of the invention is to provide a device of the character mentioned which may be readily attached to and detached from motor vehicles without materially changing the structure of any part of the vehicle. A further object is to provide a device which will be illuminated whereby it may be seen at night, and so constructed that the light will be automatically turned on when in display position and turned off when hidden.

AUXILIARY AIR FEED.—P. E. KLINE, 643 Dewey Ave., Bridgeville, Pa. The invention relates to auxiliary air feeds used upon internal combustion engines, and applied more particularly to such internal combustion engines as are used upon automobiles, the particular purpose being to increase the efficiency of the air feed of the engine. The device can be adjusted with extreme nicety so as to admit any desired quantity of air over and above that which is always supplied by the carbureter.

REVOLVING BOTTOM DUMP WAGON.—E. G. LEDYARD, 1125 S. Prairie Ave., Sioux Falls, S. D. An object of the invention is to provide a dump wagon in which the bottom is arranged to revolve, thereby leaving the load in a compact heap. Further objects are to provide a device of this type in which the revolving bottom may be held stationary to act as a leveling device in grading roads, and in which the end is postively locked, but may be unlocked instantly to permit dumping.

LOADING AND UNLOADING DEVICE.—J. DYER, 5560 Ardmore Ave., Chicago, Ill. An object of this invention is to provide a device that can be readily detachably applied to an automobile truck or to other supports whereby lumber or similar material can quickly be loaded upon or unloaded from the automobile truck or supports to which the device is applied. A further object is to provide a device which can be operated by hand.

RIM CONSTRICTING AND EXPANDING DEVICE.—J. L. KALTREIDER and C. F. SHRYOCK, 553 York St., Hanover, Pa. The invention relates to devices for constructing rims to allow the ready removal of the tire and for expanding a rim to effect a perfect seating of the tire. It is a purpose of the invention to provide a device which is of simple construction and easily operated in one direction to effect a constriction of the rim, and in another direction to expand the same.

AUTOMOBILE SIGNAL CASING.—S. GOLDSTEIN, 10 Stuyvesant St., New York, N. Y. This invention has reference to a signal to indicate to a vehicle in the rear the direction the vehicle in front is about to take in turning as well as a "stop" signal. The general object is to provide a signal in which convenient access may be had to the parts for examination, repair or removal. The signal is visible to those approaching at an angle as well as those directly in the front or rear.

STEERING MECHANISM FOR TRAILERS.—G. E. CONRAD, Box 55, Stillwater, Minn. An object of the invention is to provide mechanism adapted for connection with the guiding wheel of a trailer, and so arranged that the guiding wheel will be swung by the turning of the power vehicle to constrain the trailer to follow the power vehicle, and having mechanism for locking the guiding wheel in straight position, normally releasable and operable from the power vehicle.

VEHICLE WHEEL.—H. D. REY, Avarua, Island of Raratonga, New Zealand. The invention has for its object to provide a wheel especially adapted for vehicles, but suitable for wheels of any character, wherein the spoke portions of the wheel are arranged between holding means on the rim and holding means on the hub, the holding means being adjustable to tightly clamp the spokes in place.

AUXILIARY TREAD ELEMENT FOR VEHICLE WHEELS.—E. S. HOWARD, 145 Hudson Ave., Red Bank, N. J. The general object is to provide an attachment for the wheels of automobiles and trucks adapted to be applied to the wheel at the rim and present a lateral annular flange to constitute an auxiliary tread radially inward from, and at a side of the tire, so that when the vehicle encounters soft ground and the wheel sinks to the wheel rim the auxiliary tread will be brought into action.

TRACTOR.—J. C. WOOLEY, University of Missouri, Columbia, Mo. The invention relates to self-propelled vehicles, and has particular reference to means for maintaining level the frame of the vehicle by the medium of eccentrics within the running wheels; for this purpose means are provided to turn the eccentric bearing elements of the two tractor wheels, in opposite directions, for maintaining the frame of the tractor level, when the same is traveling upon a hillside.

FAN.—L. H. SOHN, Huron, So. Dak. This invention has for its object to provide a fan especially adapted for use with motor vehicles, the fan blades being adjustable to vary the inclination of the blades with respect to the axis on which the fan rotates. To permit the fan to be adapted for different weather conditions, mechanism is provided for permitting the fan to be adjusted from the seat of the vehicle.

MOTOR SLEIGH.—G. BROWNLEE, 1080 Richmond Ave., Victoria, B. C., Canada. The invention relates more particularly to a vehicle for traveling over ice or snow. The principal object is to provide a running gear which particularly fits the same for travel over uneven surfaces, with the transmission of a minimum amount of shocks and jars. Another object is to provide means operable from the driver's seat for controlling and regulating the engagement of the traction elements with the ground surface in order to obviate the necessity of cutting off the motor when it is desired to bring the vehicle to a stop.

SCOOP BOARD.—W. J. COMBS, Box 24, Otterbein, Ind. An object of the invention is to provide a board especially adapted for use with wagons having flaring sides, and used for hauling grain, or granular matter, wherein the board provides an end gate capable of being entirely detached from the bed, and wherein the pressure upon the board or gate may be first relieved before the gate is open and in position to be used as a scoop board.

COMBINED VARIABLE SPEED CLUTCH AND FREE WHEEL DEVICE FOR MOTORCYCLES.—A. H. TRAEGER, Kensington Gardens, South Australia, Australia. The invention comprises a variable or expanding V pulley secured on the engine shaft but having a loose ring at the bottom of the groove, such pulley being connected by a belt to a rigid or non-expanding V pulley secured to the rear or driving wheel, the axle of the rear wheel being carried in plates movable toward or from the variable pulley, the expanding V pulley being operated by a control lever with a connection also to the plates carrying the axle of the rear wheel.

GREASE GUN.—A. WHITE and M. GRANUM, Montevideo, Minn. This invention has for its purpose the provision of a grease gun which is adapted to lubricate vehicle axles without the necessity of removing the wheels from the axles. The barrel of the gun is applied to the axle by placing it over the axle head, where it is threadedly engaged.

Designs

DESIGN FOR A COMBINED WATCH AND KEY RING STRAP.—D. R. MCCULLOUGH, 2212 E. 20th St., Oakland, Calif.

DESIGN FOR MOTORMETER.—P. F. BEAULIEU, Bend, Oregon.

DESIGN FOR A LIGHTING FIXTURE ARM.—A. MILLER, 2091 Prospect Ave., Bronx, New York.

DESIGN FOR A NARROW FABRIC.—D. C. FRANK, c/o Peigram & Meyer, 4th Ave. and 28th St., New York, N. Y.

DESIGN FOR A TOY.—R. L. HERMAN, c/o Mrs. Margaret S. Bartlett, 56 S. Walnut St., East Orange, N. J.

We wish to call attention to the fact that we are in a position to render competent services in every branch of patent or trade-mark work. Our staff is composed of mechanical, electrical and chemical experts, thoroughly trained to prepare and prosecute all patent applications, irrespective of the complex nature of the subject-matter involved, or of the specialized, technical or scientific knowledge required therefor.

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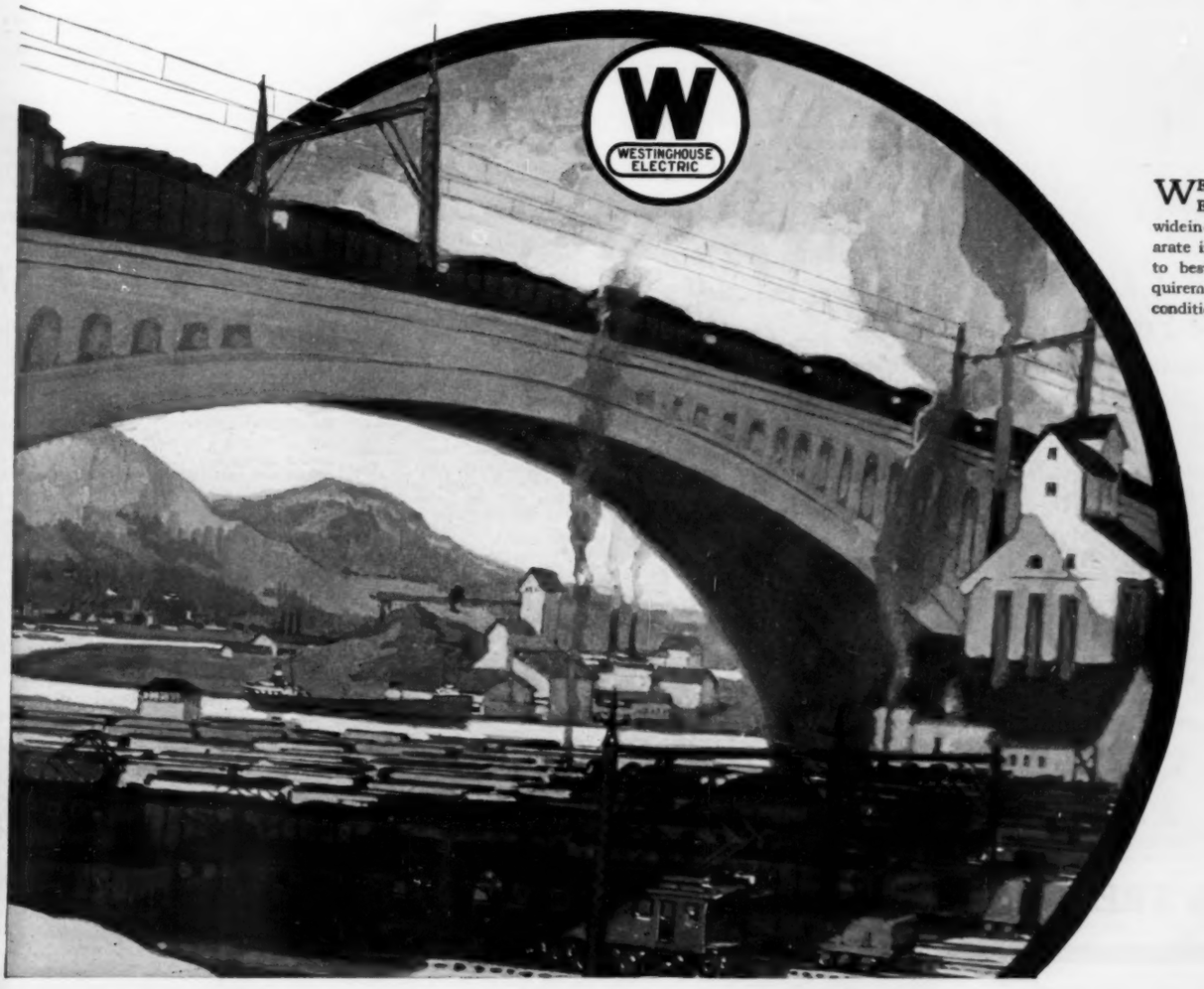

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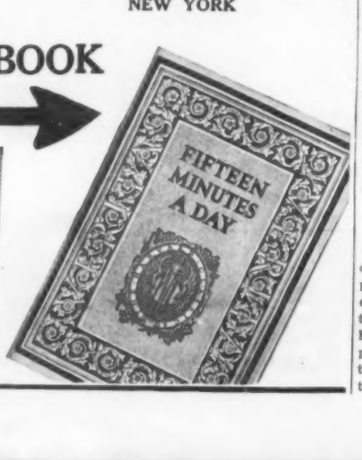

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Book Reviews

A Survey of Recent Technical Works Published Both Here and Abroad

CHEMICAL ENGINEERING CATALOG. 1921. New York: The Chemical Catalog Company, Inc. 4to.; 1294 pp.; illustrated. Leased to chemists and the trade at $2; also on general sale.

This Catalog is not merely a splendid directory; it has become an institution delivering unrivaled service to the chemical industries, with the authority of the three great chemical societies of the country behind it. Its new format attractively combines durability and dignity, the thinner paper lightens the volume by several pounds, and the contents present the gist of a library of individual illustrated catalogs, conveniently assembled and indexed, supplemented by a classified directory of equipment and supplies, and an extensive bibliography. The whole constitutes a dependable work of reference with precise data, specifications and tables. Engineers, managers, buyers and purchasers will find the work so helpful as to produce the conviction of indispensability.

P-W-R MANUAL. Philadelphia: Powers-Weightman-Rosengarten Co., 1920. 8vo.; 471 pp.

This reference work may be used to great advantage by any who deal with industrial and pharmaceutical chemicals and their derivatives. The bulk of the space is occupied by concise descriptions of the various substances—ingredients and proportions, physical characteristics, solubility, and reactions. Other pages tabulate the international atomic weights for 1920, give and compare the metric and U. S. systems of weights and measures, deal likewise with thermometric equivalents, and include the specific gravity tables and equivalents of volumetric solutions. It is a decidedly valuable compilation.

HOW TO KEEP INVENTION RECORDS. By Harry A. Toulmin, Jr., J.D., Litt. D. New York and London: D. Appleton and Company, 1920. 8vo.; 85 pp.; forms.

While the first part of this book merely summarizes the principles on which patents, trademarks and copyright receive government protection, the main section presents, with a view to preventing litigation or lightening its expense, a series of record forms that, properly used, would frequently prove priority of invention or use. These forms include summary card, preliminary sketch sheet, research record, material purchase record, etc. In their direct bearing on the development, testing and control of inventions they are of considerable interest to manufacturers and large plants.

LESSONS IN ELECTRICITY AND MAGNETISM. By William S. Franklin and Barry MacNutt. Bethlehem, Penn.: Franklin and Charles, 1919. 8vo.; 254 pp.; illustrated.

A good elementary course for colleges and technical schools is provided in this text. The authors believe in the use of the more powerful mathematical methods from the start, and as the two-year schedule in physics deprives teachers of the college-course mathematical basis, their method fills a need. It reduces descriptive and explanatory material to a minimum, but so develops its topics as to lead directly into illustrative numerical problems. Chapters on electron theory and electrostatics are particularly good.

HOW TO MANAGE THE DYNAMO. By A. E. R. Bottone. Revised by C. Sylvester, A.M.I.E.E. New York: Isaac Pitman and Sons. 16mo.; 77 pp.; illustrated.

A simple book of instruction to dynamo attendants who are not expert electricians. It gives a clear understanding of shunt, series, and compound wound dynamos, of the component parts and behavior of modern machines, of testing with the milli-voltmeter, and of exciter operation and control.

MOTORCYCLES AND SIDE CARS. By Victor W. Pagé, M.S.A.E. New York: The Norman W. Henley Publishing Co., 1920. 8vo.; 693 pp.; 370 illustrations.

As every motorcyclist knows, there is a dearth of really good handbooks dealing with the power-propelled cycle; but the dearth is of no consequence to the man who has this much-improved treatise at hand, which adequately describes all leading types, American and foreign, with the principles of operation. The parts most subject to wear are enumerated, and complete instructions cover starting and driving. The engine receives minute attention, a new chapter having been added on its thorough overhauling and repair. The new automatic lighting systems are made intelligible; and the abundant illustrations, many of them prepared by leading manufacturers especially for the work, constitute a valuable feature of the handbook.

THE MICROSCOPE. An Introduction to Microscopic Methods and to Histology. By Simon Henry Gage. Ithaca, N. Y.: The Comstock Publishing Company, 1920. 8vo.; 474 pp.; 250 text figures.

Time and again Professor Gage has rewritten his standard work, and we find this thirteenth edition again embodying the latest means and results, illustrated by abundant drawings. It makes a feature of dark-field microscopy, with the new apparatus; shows details of a new and successful lamp; gives a method of producing line drawings from photographs; and has an enlightening section on the unit of measure for microscopic objects and for light waves. Progress in the general field is set forth in a symposium held last year by British societies.

TYPES OF MENTAL DEFECTIVES. By Martin W. Barr, M.D., and E. F. Maloney, A.B. Philadelphia: P. Blakiston's Son and Co., 1920. 8vo.; 179 pp.; 188 illustrations.

Those whose work lies among the feeble-minded need to know how to class these subjects properly, that the needs of the case and the possibilities of amelioration and progress may be early ascertained. This book facilitates diagnosis of mental, moral and physical defects, and presents the stigmata of degeneracy and the usual tests. Its classification begins with the separation of hopeless idiots and trainable imbeciles; there is a rather full study of cases, with numerous photographs, making the work distinctly helpful toward practical results.

PRIESTLEY IN AMERICA. 1794-1804. By Edgar F. Smith. Philadelphia: P. Blakiston's Son and Co., 1920. 12mo.; 173 pp.

Finding the name of the discoverer of oxygen of frequent occurrence in the annals of American chemistry, the author of this little book instituted a research into Priestley's activities during his exile in this country. Here we see him industriously mixing theology and politics with his experiments, and discovering carbon monoxide. It is unfortunate that his obsession by the phlogiston theory cheated him of further laurels and of truer interpretations. The book outlines his life here from all angles, and is wonderfully interesting.

HANDBOOK OF BUILDING CONSTRUCTION. Two volumes. Edited by George A. Hool, S.B., and Nathan C. Johnson, M.M.E. New York: McGraw-Hill Book Company, 1920. 8vo.; 1474 pp.; illustrated.

Architects, designing and constructing engineers, and contractors will recognize in this work a successful effort to supply them with a vast amount of data in concise and convenient form. An imposing array of specialists have had a hand in the work, so that the reader may place implicit trust in the various departments of information. Part I has the principal elements of structural theory, types of modern buildings, designing and detailing of structural members, general data, methods and equipment, and materials; Part II covers estimating and contracting; and Part III mechanical and electrical equipment. Commendation is due Mr. C. E. Ives for his drawings from which the zinc etchings were made.

AUTOMOTIVE IGNITION SYSTEM. By Earl L. Consoliver, M.E., and Grover I. Mitchell, B.S. New York: McGraw-Hill Book Company, 1920. 8vo.; 269 pp.; illustrated.

This new work offers a systematic course of study to all interested in automobiles and airplanes, whether they be owners or repairmen. Beginning with a sketch of electrical and magnetic principles, the work deals in an explanatory way with batteries, the jump-spark system, modern battery systems, the low-tension magneto, modern high-tension magnetos of both armature and inductor types, the care and repair of ignition apparatus, and ignition troubles and remedies.

Miscellaneous Notes

Vegetable Flours.—Flour has been successfully made from both black and white beans, and a Brazilian installation is now turning out these vegetable flours.

Weekly Road Maps.—The Wisconsin Highway Department has been publishing every week a blueprint map showing routes and road conditions. The subscribers are chambers of commerce, hotels and garages. New construction, detours, etc., are plainly indicated.

How Athens Cleans House.—The dunce-cap method of correction is being employed by the Athens police in a clean-restaurant campaign. Finding restaurateurs unamenable to polite persuasion, they now give the owner three days' notice; if inspection at the end of that time shows no marked improvement, a large placard is placed over the door, with the legend, "This Restaurant Is Not Clean."

A Toy for England's Queen.—The Queen of England is to have a doll's house. Sir Edwin Luyten, the distinguished architect, will supervise the construction, and famous artists and decorators, including Sargent, will ornament and beautify the interior. The house will be eight feet high, and representative of modern domestic civilization and art. Miniatures of the royal family will adorn the walls, and tiny statues will lighten the rooms.

"Has It Been Worth the Trouble?"—An anonymous letter received by Webster, condemning his "Poker Portraits" as disgraceful, moves the cartoonist to review the march of humanity. In pictures, he traces the evolution of animal life from the Palæozoic age to the Neanderthal and Cro-Magnon men, and thence to the blue-law fanatic. The fact that it has taken 360,000,000 years of evolution to produce this "sublime result" has shaken his faith in the progress of humanity.

Lifebelts for Violins.—When the Ostend mail boat carrying Jan Kubelik ran down a freight steamer in a fog, the violinist lost no time in seizing a life-belt. No fear for his own safety influenced him, for the belt was carefully buckled, not about himself, but around the case containing his beloved Stradivarius, which he values at $125,000. While the freighter went down with the loss of two lives, there was fortunately no need for consigning the violin to the mercies of the Channel.

Night Terror in Children, according to Dr. Hamburger, can be cured only by suggestion, since it is invariably some psychic trauma that influences the dreams; the child is still asleep, or at least dream-dizzy, even though he sees and can answer questions. Dr. Hamburger administers a placebo, assuring the child that it will bring a night of unbroken sleep. It should be noted that the shrieking of a child on the verge of a febrile disease is often mistaken for genuine *pavor nocturnus*.

The Cruise of the Ship-Shop.—The decks of the *Raoul Briquet* have been turned into little streets of shops with famous firm-names over the windows. In this miniature Paris may be bought most of the wines, lingerie, medicines and toilet articles for which the real Paris is famous. The ship-shop is now visiting the Baltic seaports, and is everywhere enthusiastically received. A press campaign precedes her arrival, and the idea is full of commercial possibilities. More ship-shops are planned, to tour the ports of the world.

Paris to Be Finger-Printed.—Following the armistice 3000 criminals were loosed on society, and Paris has known a reign of terror. In an attempt to remedy conditions, the Prefect of Police is requiring every one, even casual travelers, to show identification cards bearing their finger-prints; these cards are provided free, and there is a heavy penalty for failing to obtain one; they will, by providing prompt identification, facilitate all official and banking transactions. Movies and newspapers have been blamed for the crime-wave, but Lebon says juries provide the most fertile field for contagion. "The microbe of crime," he adds, "only attacks organizations already prepared for it."

Flirtatious Islands.—French grammar is right, for once, when it designates islands as feminine; many of them appear and disappear like a face behind a fan, and have to be wooed fervently before they are won. Charcot's recent landing on the "lost" island of Rockall, east of the Hebrides, recalls other elusive islands. Jan Meyen modestly veils herself in mist, and is seen but once in 50 years, while an islet in the Behring Straits surrounds herself with water so hot that fishermen say approach is impossible. Derwentwater has a bathing nymph of an island that floats for six weeks, then coyly submerges; Lenge, the explorer, made his home on a similar one at the mouth of the Amazon, until the island capsized in an attempt to get rid of her guest.

Rain Insurance Popular.—Outdoor business undertakings and sporting events are peculiarly dependent upon dry weather for their profits, and a few hours of rain may cut these to zero. S. K. Pearson, Jr., of the Weather Bureau, notes the growing practice of guarding against loss by taking out rain insurance policies. Several companies have established "Pluvius Departments," and these make the Weather Bureau's data final and binding in the settlement of claims. The premiums are high or low, according to local precipitation statistics. New York City has rain, on the average, every three days, with a normal annual fall of 44.63 inches. Last summer, with its lengthy dry periods and all its holidays free from rain, found the insurance companies on the winning side of the wager.

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Starrett Steel Measuring Tape

In steel or leather cases, flush handle with push button release on opposite side. Graduated in English or Metric systems, as desired. Finished in black background, with bright steel figures and graduations with the foot figures before each inch mark, insuring quick and accurate reading. Bright background and black figures if desired. Lengths from 25 to 100 feet.

Starrett Improved Mercury Plumb Bob

Made from solid steel, bored and filled with mercury. Nickel plated and knurled. Points hardened and ground. Patented slotted neck for fastening string without knots, allowing bob to hang perfectly true.

Starrett Improved Level

In addition to regular parallel vial, the base has a cross level, insuring the accuracy of the level when in a canted position. The concave groove running the length of the base, with flat margin on either side, improves the seat for flat work and gives an absolutely true seat for shafting, etc.

Starrett Leveling Instrument

Light in weight and of simple construction. Tripod of iron, with telescoping extension legs, adjustable to any length. Light tube fitted with eye aperture and cross wires. Head is held to tripod with bolt and nut, so as to make it stationary at any given point.

Starrett Key-Seat Rule

Consists of machinists' scale and an auxiliary straightedge held together to form a box square. The auxiliary straightedge is either plain or graduated in 32ds or 64ths, as desired. Is also made with graduations in the Metric system.

Starrett Key-Seat Clamps

Of case hardened steel and ground accurate; will transform any common scale into a Key-Seat Rule. May be used with Starrett Combination Square Blades or any straight rule.

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Patents and Trade-Marks

General Principles, Current Comment, and Interesting Decisions

German War Patents in France.—Notwithstanding the fact that by the Treaty of Versailles Krupp's may manufacture only the devices of peace, this establishment has since the armistice taken out eight patents in France for guns, gun equipment, and a periscope for war submarines.

Fountain Pens Centuries Old.—Travelers were using fountain pens in 1600, and reference to them is found in an advertisement of 1788. About that time they assumed their present name, but did not come into anything approaching general use until fifty years ago. British patents were granted for fountain pens in 1809, one being to Joseph Bramah, the inventor who gave his name to the Bramah lock and the hydraulic press.

Recording Articles of Incorporation.—Articles of incorporation are now being recorded by the Patent Office at the request of attorneys, in order that the corporate names may be available for trademark searches. This course is due to an order of the present commissioner, Mr. Robertson, although the Patent Office does not advocate the procedure. As long as the practice continues a charge will be made for such recording of $1.00 for 300 words or less; $2.00 for more than 300 words and less than 1000 words; and $1.00 for each additional 1000 words.

Trademark Section of Official Gazette.—In response to the public demand a section of the Official Gazette containing all matters relating to trademarks may be procured separately, beginning with volume 290, September 6, 1921. The trademark section will include: Trademarks published under the act of 1905; trademarks registered under the act of 1905 and under the act of 1920; labels and prints; the indexes, and decisions from time to time in trademark cases. The cost will be five cents for each number, or $2.50 for annual subscriptions, to which must be added $2.00 to cover postage to subscribers in foreign countries.

First Use of Trade Mark.—The question often arises as to whether or not a trade mark registration can be obtained prior to the sale of the article with which it is sought to be used, so as to prevent another manufacturer from appropriating the trade mark. Trade mark rights can only be obtained through adoption and use of the mark in question, and the one who first so uses the mark becomes the owner, irrespective of any question of registration. It is absolutely necessary that the trade mark be used in association with the merchandise which it identifies, in interstate or foreign commerce, prior to the filing of an application for federal trade mark registration.

Inter-Departmental Conference.—On July 25th last at Washington, D. C., an Inter-Departmental conference was held for the purpose of formulating some plan looking to a coordination of the views now held in the various bureaus and departments of the Government in regard to patents arising within the Government service. The meeting was of considerable interest in view of the many inventions created and patents obtained by members of the Government service while in such service, the purpose being not only to protect and safeguard the interests of the individual but the rights of the Government as well. No definite plan has been as yet formulated, the discussion being merely preliminary, but it is hoped that considerable progress will be made.

Can a Patent Be Attached?—A patent is personal property, a chattel; and, as such, may be transferred to another. The transfer is effected by means of a deed of assignment which sets over the entire or part interest in the invention and the patent covering it. However, a patent cannot be attached as can other property, by a judgment creditor. A court of equity may, however, direct the sale of an inventor's interest in his patent to satisfy a judgment against him, and it will require the patentee to assign, as provided in the Revised Statutes, Section 4898; and if he refuses, the court will appoint a trustee to make such an assignment. A patent right cannot be seized and sold on execution. On the death of the inventor or the assignee of the patent, the title therein passes to his administrator or executor.

Utzman Patents for Gypsum Plaster Board.—The two Utzman patents Nos. 1,029,328 and 1,034,746, covering respectively a process for making plaster board and the plaster board product, have recently been held valid and infringed by the United States Circuit Court of Appeals, Seventh circuit, in United States Gypsum Co. vs. Bestwall Mfg. Co., 270 Fed. 542. The decision is an interesting reiteration of the doctrine that utility, increased output, improved product and reduction in cost are all factors of importance in determining utility and invention. The Court held that the extensive use that immediately followed the appearance of the new board was sufficient to show its utility, and that in view of the factors mentioned the contribution of the patent spelled invention.

Trademark Registration of Farm Names.—Some newspaper comment has been accorded the fact that the Patent Office recently approved and published in the Patent Office Gazette a trademark covering the name of a farm of an Iowa farmer to whom the registration was issued and who is a breeder of purebred hogs. The registered trademark name is "Hawkeye." However, this procedure is not entirely novel, and trademarks have frequently been registered in the past for farm products, shrubs, plants, and the like. There is no reason why that should not be the case, as such products may certainly be "goods, wares and merchandise" in the sense of the trademark law, as may any other commodities. It would in fact be an excellent idea if more producers of natural products such as fruits, vegetables and the like would register their trademarks or trade names for the same. It has been done in a large measure by numerous fruit growers associations, canners associations and similar bodies.

Equitable Maxim in Case of Unfair Competition.—It is a maxim of equity that he who would demand equity of the court must come into court with clean hands. The Supreme Court of the State of New York, in a recent decision (*F. L. Le Beau, Inc. vs. Valme*), has based its findings on this maxim in a case of unfair competition. The plaintiff sued to restrain the defendant from selling a hair dye in a package almost identical in appearance and name with that of the plaintiff. It appeared that the plaintiff's ware was produced in this country, but that the dress of the package clearly gave the impression that it was the production of the French company originally manufacturing it, and so the court held that "Under such circumstances the court of equity has uniformly refused to protect the use of a misleading trade name against imitation not because the defendant's misconduct is palliated by the plaintiff's conduct, but because the plaintiff has forfeited its right to relief because of its offense against the public."

Trademarks Applied to Imported Goods.—An interesting decision of the United States Circuit Court of Appeals, Second circuit, is that in the case of Bourjois & Company, Inc. vs. Katzel. The Court held that: "Where B. has bought from a French manufacturer the business and good will in the United States and sells goods manufactured by the French manufacturer, which goods bear the trademarks used by said manufacturer, and where K. imports and sells the same goods bearing the same trademarks, held that K. does not infringe by such sale. Trademarks are intended to show without any time limit the origin of the goods they mark so that the owner and the public may be protected against the sale of one man's goods as the goods of another man. If the goods sold are the genuine goods covered by the trademark, the rights of the owner of the trademark are not infringed by such sale. It is not doubted that an American citizen may buy the business of a foreigner in the United States, with accompanying trademarks and having done so may subsequently change the character and quality of the goods at pleasure."

Proceedings of the Patent Section — American Bar Association.—At the forty-fourth annual meeting of the American Bar Association the principal subject coming before the Patent section was the preliminary draft of a new Federal trademark law. This was prepared by a committee of which Edward S. Rogers, Esq., of Chicago, is the chairman. The proposed bill contemplates a complete revision of the Federal trademark statutes, a revision such as had been advocated by many of the leading trademark practitioners of the country. The bill was referred to a committee of eminent lawyers largely specialists in this field, and the committee was requested to make a complete study of the proposed bill and to report the same to the Patent section at its meeting in 1922. Copies of the bill may be obtained from the chairman, and the committee has announced that it will welcome criticisms and suggestions from members of the Bar Association. The Patent section also passed a resolution endorsing H. R. No. 7077, increasing the salaries of the employes of the Patent office, the funds for the increase to be derived from increasing the filing fee for patent applications from $15.00 to $20.00. This resolution of the Patent section was subsequently adopted by the Bar Association.

Employment of Another to Assist in the Reduction to Practice of an Invention.—When an inventor hires a mechanic or engineer to assist him in reducing an invention to practice, the question frequently arises as to what extent the employe actually participates in the creation or development of the invention, for obviously as the work proceeds the employe skilled in his field may readily devise changes or improvements. The courts have repeatedly passed upon this question and: "It is a well-established principle of the patent law that where an inventor employs another to embody his conception in practical form he is entitled to any improvement therein due to the mechanical skill of the employe; but if the latter goes farther than mechanical skill enables him to do and makes an actual invention, he is entitled to the benefit thereof. An invention does not lie in the idea that a certain result would be desirable, but in the conception of the means for accomplishing that result, and one who claims the benefit of the work of another must show that he communicated to the one who did the work an idea of specific means for accomplishing the desired end." See also Sparkman v. Higgins, 1 Blatchf. 206; Yoder v. Mills, 3400 G., 1048; 25 Fed. Rep. 821, Huebel v. Bernard 90 O. G., 751; 15 App., D. C. 510; Agawan v. Jordan, 7 Wall, 583; Neth & Templin v. Ohmer & Ohmer v. Ohmer, 135 O. G., 662."

Electrical Notes

Summaries and Excerpts from Current Periodicals

Electricity Kills Two.—An unusual accident occurred when an electric charge passed through a car of the New Haven railroad near Noroton, Conn. The car was one of a circus train and was occupied by colored minstrels. Following a sudden flash and roar, two were killed and many injured. Officials of the road lay the cause to a 2-inch water pipe projecting 11 inches above the roof of the car, which must have formed an arc with the overhead high-tension wires.

High Resistance in Small Packages.—A 50,000 ohm resistance unit in a space that could be covered with a business card is a specimen of the compact resistances being made by a New York concern. In fact, it is not the length of the resistance units nor their width nor their thickness that give the high resistance; but it is the fundamentally new principle being applied to their construction. Furthermore, these units are guaranteed absolutely non-inductive.

Additional Service from Dry Battery Carbons.—A method of reclaiming the carbons of dry cells instead of discarding them appears in a recent issue of *Engineering*. It is said that experiments tend to show that the cleaning of the electrodes and the removing of the deposits clogging the pores of the bag and of the depolarizer are more important than the actual reoxidation of the manganese. This is fortunate, for the reoxidation can not be effected by the simple chemical means.

Beauty with Utility.—The prevailing mode in highly ornamental ceiling lighting fixtures calls for a tassel—at least an imitation tassel of solid metal. It has remained for a Philadelphia manufacturer to find a use for the usual metal tassel aside from pure ornamentation, and this he has done by making it in the form of a neat receptacle which can be used for attaching the plug of a table lamp. If a plug is not used, a cap is fitted over the bottom of the tassel to cover the receptacle.

New Wireless Weather Service.—A new radio service is announced by the Weather Bureau, cooperating with the Navy Department, for the benefit of aviators and mariners. It comprises, first, a special bulletin containing surface weather observations from aerological station, military and civil, with a summary of weather conditions, forecasts and warnings; and, second, a localized service that broadcasts forecasts and warnings from naval stations. Full details may be had by application to the Chief of the U. S. Weather Bureau, at Washington.

A Mysterious Stove.—At a recent electrical exposition a "mystic stove" attracted no little attention. This idea is by no means new; in fact, in one of its most spectacular forms it consists of a kettle of water boiling on a cake of ice. The solution of such mysteries is powerful magnetic induction, which causes the generation of powerful electric currents in the pot, pan or kettle. The layman is, of course, greatly mystified, since water can be boiled, eggs fried, and so on, with no visible source of heat. The hand can be passed over the tapestry-covered table without feeling any trace of heat.

Toaster and Electric Heater Combined.—A New Yorker has developed an unusual form of electrical heating apparatus that may be used either as a heater or as a toaster. This device is made entirely of copper or brass and as a heater sits upright on fiber legs. In front is a removable wire guard, while an elliptically curved copper reflector serves as the back. The coil type heating element inside is mounted upon a porcelain spindle equipped with a lamp socket base so that it can be readily taken out. Through the design of the reflecting surface, the heat rays, so it is claimed, are distributed over an angle of 100 degrees.

Mt. Tamalpais Searchlight.—News comes from San Francisco to the effect that Mt. Tamalpais is to have a powerful searchlight. This mountain is directly across the Golden Gate from the city, and is about 2500 feet high. A 60-inch high-intensity searchlight is to be installed on the summit, commanding an obstructed view of the surrounding country and the sea. It is claimed by the builder of this searchlight that its beam is approximately 500 times more powerful than that of the largest locomotive headlight. When the atmosphere is clear the searchlight will pick up a battleship 12 miles distant, and the shaft of light will be visible at a distance of over 100 miles.

Electrifying the World.—Far lands are buying our electrical goods as never before; we flood the most obscure corners with light; our telephones vibrate to every tongue; the click of our telegraphs encircles the globe. Exports of electrical machinery and appliances went from $19,000,000 in 1915 to $54,000,000 in 1918, leaping to $119,000,000 in the fiscal year 1921. The 17,000,000 electric lamps went to 75 different countries, the $5,000,000 worth of telephones to 60, and the 88,000 fans to more than 70 different countries; $2,000,000 worth of heating and cooking devices were also exported broadcast. All this makes of prime importance the announcement of a new "Division of Electrical Machinery" in the Department of Commerce.

Early Days of Electric Railroads.—The first electric railway in the world was installed by the pioneer Siemens at the Berlin exhibition in 1879, according to the American Electric Railway Association. The current was taken through a dynamo and conveyed through the rail. In 1886 a line was constructed by Leo Draft in Baltimore and this seemed to have been fairly successful. The first successful overhead trolley line was installed in Richmond, Va., by Frank J. Sprague in 1887. A score of short lines were built throughout the United States during the period of 1885-87. Most of them ran but a short time. The real start of the electric railway came after Sprague had completed his Richmond line.

British Radio Nomenclature.—Anyone who has had occasion to engage in a conversation with an Englishman or has read English literature has soon discovered that the English of Great Britain and the English of the United States have numerous differences. British radio nomenclature, in this connection, is of interest. The English radio man calls his vacuum tubes, radio valves. His tuning coil is an inductance coil. Binding posts are terminals. Amplifier transformers are intervalve transformers. Vacuum tube sockets are valve holders. Telegraph keys are tapper keys. Contacts for switches are contact studs. Hard rubber is ebonite. Condenser plates are condenser vanes. The radio amateur is the amateur wireless enthusiast.

Pantagraphs and Trolleys.—Writing in a recent issue of *Revue Generale de l'Electricite*, M. P. Le Boucher gives first a theoretical study of the most desirable requisites of a pantagraph current collector, such as (1) steady pressure, irrespective of height of wire; (2) great lateral steadiness; (3) small air resistance, and (4) small inertia, so as to follow easily any change in height of the overhead wire. About sixty different pantagraph arrangements have been tested by this author, and the results are given in tabulations and curves. While it is American practice to maintain an average pressure of 11 kg. per square centimeter of the pantagraph against the wire, French railways use only 4 kg. to 8 kg. per square centimeter.

Direct-Current Railroad Electrification.—Despite all that has been said regarding the advantages of alternating-current transmission, there are more and more proofs daily that direct-current transmission over moderate distances has by no means gone out of style. The commission appointed in January, 1920, to study the desirability of electrification of all railways in Holland has prepared a report which, it is understood, not only favors such a scheme, but recommends the use of 1500 volts direct current. It is also recommended that the electrification be made in connection with the proposed unification of electric light and power service throughout the country. There is no indication, however, that this work will be undertaken in the near future, according to Consul-General George E. Anderson.

Novel Storage Battery for Radio Work.—The requirements of radio reception work are such that the usual storage battery is not altogether satisfactory for the operation of vacuum-tube filaments. To the end of evolving a storage battery especially intended for radio work, an American has recently introduced a battery of radically new design. This battery is claimed to be noiseless and to eliminate troubles often attributed to static, but which are really due to defective "B" batteries. It consists of twelve cells of the lead-acid type, giving 24 volts, in one unit. The capacity is 10 milliamperes for eight hours, or 50 milliamperes for one hour. It will furnish 300 milliamperes for a short time, which makes its use possible for C W and radio telephone transmission. The elements of this battery are assembled in a vertical pile, and appear very much like a pile of plates. The assembled battery is shipped ready for use, except for a small quantity of electrolyte that must be added to each cell either with a medicine dropper or by dipping the whole battery unit into a vessel of electrolyte.

Welding and Cutting Arcs.—Speaking of electric welding operations before the American Electrotechnical Society, an American authority stated that immediately after drawing a short arc, the plate metal first liquefied appears to be blown from the crater terminal. Under proper conditions it is therefore possible to convert the welding arc into a cutting arc. While the source of this blowing action has not been definitely established, the following effects appear to be contributory: 1. Impact of ions, cathode vapor, gases, and globules. 2. Atmospheric convection currents. 3. Sudden liberation of gases confined in anode material. 4. Pressure on anode surface of gases formed by combination of incandescent metal constituents with atmospheric gases. In the past, investigators of arc phenomena have confined their attention chiefly to the behavior of low-current arcs. The problems, however, confronting the welding, searchlight, fuse, and circuit-breaker engineer can only be solved with a proper knowledge of high-current arc phenomena. While certain fundamental characteristics are common to both types of arc, it is evident that the complexity of the phenomena may increase with increase in current, rendering more difficult their proper interpretation and retarding their most effective utilization.

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Aeronautical Notes

Recent Activities and Forthcoming Plans That Mark the Progress of Mechanical Flight

Amphibian Passenger Service.—Conveying passengers between central London and central Paris, alighting on the Thames and the Seine, amphibious planes are to cut time and expense by making trips by auto to outlying airdromes unnecessary. The machines are so built that in emergency they can safely come down on land. This service will soon be put to a thorough test.

An Unusual Italian Monoplane.—An airplane capable of landing without the need of a large aviation field, able to rise without a long run beforehand, able to travel more than 300 miles an hour and, if necessary, to drift along at a few miles per hour, is announced to be the invention of an Italian engineer, E. Bertucci of Rome. The inventor claims to have tried out the machine on a small scale, and regards his experiments as proof of the success of his invention.

French Activities.—The French military air service will have more than 40,000 airplanes next year if the Army budget passes into law without serious alterations. The French Flying Corps would then have 286 regiments, each of 12 squadrons. French airplane constructors are in a very strong position, mainly because the French Government, to help the industry, allowed the constructors to execute most of the outstanding war contracts. French constructors have on hand substantial orders from Japan and South America.

A Good Start for a New Machine.—Much interest attaches to the new British biplane, the Mars I, which was the winner of the Derby held at Hendon during the middle of last July. This machine is the creation of Mr. H. P. Holland and was built by the Gloucester Aviation Company. It is equipped with a 450-horsepower Napier "Lion" engine. The rear part of the fuselage of the Mars I is very much like that of any other fast scout machine, but the forward part is distinctly different, and accounts in large measure for the remarkable performance. The front portion of the fuselage is quite high, so as to take care of the engine and the water-cooling system, as well as the gasoline tank.

A Two-Cycle Engine of new design, especially intended for aeronautical work, is being constructed in Cleveland. The engine, so the report has it, is of the radial type with six cylinder units, each unit being made up of two cylinders, the pump cylinder and the firing cylinder. The former draws the fuel from the carburetor and forces it at a high velocity through a by-pass port into the latter just as the exhaust port begins to open. The damp charge falls on the burnt one like a blanket, scavenging the fired cylinder completely. The crank shaft and connecting rods operate similarly to those of the conventional four-cylinder radial engine. The fuel consumption of this engine is expected to be exceptionally low.

A 4000-Pound Aircraft Bomb.—The Ordnance Department of the Army is making plans for an aerial bomb to weigh 4000 pounds, which is very much larger than any bomb of the kind ever before conceived in the United States. It is to contain over 50 per cent or 2400 pounds of TNT, and will be one of the most deadly of all bombs known in modern warfare. Up to the present the largest bombs designed and constructed weigh but 2000 pounds. These already have been adopted as standard, together with bombs weighing 1100 pounds, 600 pounds, 300 pounds, and 100 pounds, respectively, all of which contain about 50 per cent of TNT. The new bombs weighing 4000 pounds are to be used in connection with the largest bombing airplanes.

Aircraft Insurance Rules.—It is interesting to note how insurance companies are now ready to accept the air craft and its passengers as a reasonable risk. During 1921 several changes have been necessitated by reason of the heavy losses during 1920. While the executive committee of the National Aircraft Underwriters Association felt that the rates must be kept down as low as possible, it has found it necessary to take certain precautions. It has been decided, therefore, that fire, transportation, theft, windstorms and collision coverages shall all embrace the 75 per cent loss payable feature, whereby the company pays three-quarters of each loss (or three-quarters of the excess portion of each loss) for each coverage that bears a deductible feature. The companies hope to bring about considerable improvement by the use of this clause. There is no question but that an insured person will be a little more thoughtful and perhaps a little more careful if he knows that he is not to be fully reimbursed for each loss that may occur.

The Bourke Turbine Propeller, according to *Aeronautics*, is a new type of airscrew construction which is built on lines that are quite contrary to the usually accepted theories of propeller design. In brief, the turbine type is simply an ordinary airscrew which has vanes projecting on both sides. The actual size of the vanes, their position on the airscrew, their intervals, the material from which they are made, and the method of fixing them has been the subject of a great deal of thought and experiment on the part of Mr. Bourke, the inventor and patentee, and Mr. J. W. Carr, his technical engineer and consultant. It is claimed for the turbine principle that it is not only more efficient, but that it also causes a marked reduction of vibration and noise. Its use is by no means confined to aircraft, but applies also to water propellers, ventilating fans, and the like. As regards the method of construction, the vanes are made of steel and screwed on to the wood of the propeller. Experiments were made with aluminum, but it was found that this would not stand up to the work.

Bolshevik Aviation.—It appears that the Red Army of Russia has not lacked airplanes despite its numerous campaigns on many fronts. In fact, during the latter part of Russia's participation in the World War as one of the Allies, most Russian airplanes were of domestic manufacture; and when the Bolsheviks came into power they naturally came into possession of the aircraft factories. The main problem of the Red Army as far as aviation is concerned, has been to find faithful pilots. Numerous Bolshevist pilots surrendered to the Whites, despite the fact that they had Communists for observers, and many valuable military secrets were thus revealed to the volunteer army. To overcome this difficulty, the Bolsheviks began to train Lithuanians and Chinese. The results, however, were poor, for the new pupils crashed so many machines that the only producing aircraft factory, Dux, could not keep pace with the spare parts and new machines required. Finally, the Bolsheviks limited their activities to scattering propaganda from the air. The naval end, however, is said to be far more active.

Flexible Fuel Pipes.—Though no doubt permanently fixed steel piping for gasoline and oil systems in aircraft is preferable to copper piping, nevertheless rigid piping of any kind is liable to fracture by vibration, or to damage by careless workmen, or by accident, when work is being done on other parts of the machine. Obviously, flexible piping is preferable to any kind of rigid piping if a satisfactory flexible pipe which is gasoline, oil, and water proof can be had. Hitherto, states *Aviation*, the right kind of pipe has been lacking—at any rate, since the Bowden flexible pipe was abandoned—or else, where a satisfactory pipe has been found it has been impossible to discover a trustworthy joint for it. These difficulties seem to have been overcome by a British manufacturer, in a pipe that is itself composed of an inner layer of gut—either pig, ox, or horse—strengthened by canvas and protected from external pressure by wire winding. Animal gut is found to be proof against gasoline, oil, and water. Canvas is the best strengthening material, and wire is the best anti-crush material.

New Italian Parachutes.—A recently introduced Italian parachute, while it does not differ fundamentally from the general design of such equipment, incorporates some new ideas as to detail design, we learn from a contemporary. This applies in particular to the opening device and the cover. In this parachute the shroud lines are laid around the periphery through a large number of aluminum rings sewed on to the edge of the cloth. This makes the opening of the parachute rapid and positive, and it is said to be less liable to damage than the rubber tube used as a shroud lead on the French individual parachute, which is liable to tear. The folding of the Italian parachute is also easier and in operation the opening takes place with a minimum of jerk. The collective, or nacelle parachute permits the salvage of the crew of a free balloon or a kite balloon, together with the basket, instead of the occupants, jumping singly overboard with parachutes. The nacelle parachute is fixed to the basket from the gas bag. The release gear is controlled by the pilot. It appears from trials that a basket or car weighing less than 300 pounds equipped with such a parachute will descend at the rate of 12 feet per minute.

Mine-Laying Airplanes.—With the experimental work in the tactical use of aircraft such as the making of smoke clouds to hide formations and maneuvers, the dropping of toxic gas bombs from aircraft, and the construction of airplane carrier ships, it may be expected that the Naval Air Service will conduct tests of harbor and inlet protection with mines laid from airplanes. It would be an enormous task, and an expensive one in time and material, to cover any large area in this manner, but where there exists the combination of a limited period of time for the work and a small area to be covered airplane mine-laying might reasonably be expected to be successful. Little has been done along this line, though the Germans did successfully attempt the method on the Baltic Sea in 1917, we are reminded by *Aviation*, using seaplanes of the float type, known as torpedo planes. These were two-engined machines using either 200-horsepower Benz or 260-horsepower Mercedes engines. The use of twin floats permitted the attachment of the mine, or torpedo, between them and under the fuselage. A release system was arranged so that the mine could be freed by the pilot. These airplanes were normally loaded with eight 110-pound bombs or one torpedo. In laying mines, the airplane was flown within ten to fifteen feet of the water, and the mines, which weighed 800 pounds, with an explosive charge of 440 pounds, were released, automatically anchoring after sinking to a predetermined depth.

Mechanical Engineering Notes

Survey of Progress in the Mechanical Arts Gathered from Various Sources

Metal Spraying.—The Schoop process of spraying metals has been making remarkable headway in many countries. It is now being employed for a wide variety of purposes, ranging from the spraying of zinc on iron members for outdoor purposes to spraying zinc on the back of positive glass plates so as to obtain a wonderfully effective silver picture.

Air-Operated Arbor Press.—An American builder of machine tools has recently introduced an air-operated arbor press designed for work usually performed with hand-operated presses. Arbors, bushings and similar parts are pressed into desired position with one stroke. The downward stroke of the ram is controlled by means of a stop collar, thus enabling the operator to perform delicate operations automatically. The piston is equipped with a composition cup packing supported with suitable expansion rings. This construction provides a self-adjusting piston.

Cloth That Cuts.—Remarkable properties are claimed for a special cloth recently introduced in machine shops. It is said that this new cloth takes hold, bites right into the work, as it were, leaving a finish that is clean. It stands up to its work without cracking, peeling, or losing its grain. As far as speed is concerned, it is the fastest cutting cloth yet introduced, so it is claimed. It cuts fast because it is coated with selected hard, sharp grains of a most efficient abrasive. It is uniform because it is coated with positively uniform, clean, accurately graded grain. It shows long life because it is durable and flexible.

Keyseating Long Length Holes is a difficult job under any circumstances, while it is a simple operation with a recently-introduced tool, so it is claimed. It is as simple as drilling a hole. The tool is fitted with a high-speed rotary cutter for milling internal keyseats in one cut. By passing the tool through the hole once only the keyseat is completed. This tool may be attached to the usual drill press, so that the latter can be made to mill internal keyseats in places where planer, shaper, and keyseating machines can not reach. The miller is regularly made in twenty different diameters, and eccentric bushings can be supplied for each size whereby one miller may be used in keyseating holes larger than the tool's own diameter.

Protecting the Surface.—Since the atmosphere has such a deleterious effect upon many metals, it becomes necessary to protect the metal from the air, and this is more readily accomplished by simply painting with ordinary paint, enamel or with oil. Metal coatings are also supplied, the most usual form being the familiar galvanized or tinned iron. It is well to point out here that unless the tin coating completely covers the iron base it is preferable that there be no coating at all. Iron is electro-positive to tin, and if any pinholes are present it can be readily understood that the corrosion of the iron will be accelerated rather than retarded. Zinc, on the other hand, is electro-positive to iron, and the effect of any incomplete covering of the iron base would be to corrode the zinc rather than the iron.

Radical Changes in Lathe Design are claimed by a builder of special lathes for his products. Among the distinct and radical improvements in the design of his new lathe he claims the following: 1. Constant speed motor drive; armature shaft connected directly to the drive shaft, eliminating belts, tension idlers and chain drives with their consequent trouble and inefficiency. 2. Headstock cast integral with base, increasing strength and accuracy. 3. Extra large spindle and spindle bearings. 4. Herringbone gear drive to spindle. 5. Splash oiling system gears operate in oil bath. 6. Twelve speed changes and twenty-eight feed changes. 7. Gears always in mesh—speed and feed changes made without stopping lathe—no chance of stripping gears. 8. Wide ways with 15 deg. angles, vertical and horizontal. 9. All controls on the apron at the operator's finger-tips. 10. Greater percentage of power delivered at the cutting tool than any other lathe.

Speeding Up Gear Cutting.—When a large number of gears are to be cut it has been found advantageous to make both roughing and finishing cuts at the same time by the double cutter method. Both the roughing and finishing cutters are mounted on the cutter spindle. The roughing cutter is mounted on the outside, which permits its easy removal for resharpening without disturbing the adjustment of the finishing cutter. When taking the first cut both cutters must cut through solid stock, requiring a slow feed. To avoid the loss of time and trouble, which would arise from either feeding by hand or changing gears, a leading machine tool manufacturer has designed an automatic feed change mechanism that can be furnished as an extra for use on gear-cutting machines. This mechanism is engaged for the first cut, which is taken at a slow feed. At the first reversal of the cutter the feed mechanism is automatically tripped, engaging a feed twice as fast for the remaining cuts.

Why Chain Drive?—Certain conditions, of course, make the use of belt or gear drives impossible; for instance, near a furnace where exposure to great heat is inevitable or in very dusty or dirty atmospheres. Here the belt or gear drive would be unsuitable, because the belt would soon perish in the former case and the gear would become clogged in the latter. Satisfactory chain drives can be designed to operate efficiently under these conditions. Another advantage of the chain drive over the belt is in the distance between the driving and driven centers. A belt will not operate where the center distance is too small owing to its lack of flexibility, which would mean that only very small portions of the pulley faces and the belt surface would be actually in contact. Chains can, of course, be used between wheels that are very close together, thus effecting a considerable saving in material and space, which both mean money. The high efficiency of a chain will not deteriorate even after years of hard service, provided, of course, that the chain has been well made and correctly installed. This fact, continues *Cheap Steam*, is partly due to the low friction in the drive and also to the fact that the driving strains are distributed among a large number of self-contained units.

Tests on Hollow Steel Castings.—A paper issued by the Bureau of Standards at Washington gives an account of the tests on six hollow cylindrical steel castings manufactured by the centrifugal process. The castings were 6 feet long and of diameters up to 18 inches, with holes of various diameters through them, and they were made with the mold revolving about the axis at a speed not specified. Samples of the metal taken from different parts of the complete castings were tested for hardness, tensile strength, soundness, structure, and density, both in the condition as cast and after heat treatments of various kinds. It was found that there was a slight segregation of carbon, phosphorus, sulfur, nickel, and copper in the radial direction, but none of the manganese and silicon. Small blowholes were evident in the inner 1/16 inch of the castings. After heat treatment several of the castings showed mechanical strength equal to forged materials of the same composition, and satisfied the ordnance requirements for gun forgings. Microscopic examination showed no hard spots, flaws, or other defects outside the layer 1/16 inch thick at the inner surface, and the process appears to be one of great promise.

A New Dieing Machine.—With the development of a new dieing machine the days of the old, top-heavy, vibrating punch press are numbered, so we are informed by mechanical engineers. The flywheel and crank-shaft of this machine are located below the dies, transmitting the power to a lower gate or crosshead, guided on long ways located on the frame of the machine, which takes the side as well as the vertical thrust. The lower gate is connected with the upper cross-head that carries the punch or punches, by four chrome nickel steel rods guided in long, adjustable bronze bushings. By this construction the upper crosshead is subjected to no strain except direct vertical pull applied at the corners instead of in the center, giving perfect alignment to the punch and die exactly as in a sub-press. Other advantages that are said to result from the driving mechanism being below the die plates are the following: More correct strains; greater strength; better balance; greater speed capacity; no obstructions to light; dies more accessible and better lighted; longer life for dies because of impossibility of getting out of alignment; greater life of bearings; interchangeability of bearings; less oil attention; greater production; less vibration; less attention; less labor cost.

Fine Castings in Sand.—Although it is not the process used by counterfeiters, most green sand molders know that with the exception of loss of size owing to contraction coins can be exactly duplicated by the proper preparation of the sand used for facing the molds, and in the making of fine-skinned castings this preparation is taken advantage of. The casting is an exact replica of the space in the mold, assuming that the metal is clean and the mold properly made, a rough-grained sand leaving a rough surface on the casting and vice versa; but the thickness of the facing need not be great, a quarter-inch thickness or less, according to the size of the casting being ample, the body of sand in the mold not affecting the skin of the casting; although, if not porous enough, it may affect the casting as a whole. Polishing the mold with extremely finely powdered graphite or stealite, according to the metal cast, adds to the fineness of the skin of the casting; but this point has to be largely decided by the molder, continues *The Practical Engineer*. The sand for facing should always be dried before sieving, as this largely insures the separation of the grains without removing the binding material; but the rejections should always be crushed and again passed over the sieve to prevent loss of essential parts as far as possible. With iron, coal dust is added, and with brass and bronze, pea or bean meal is made an addition to the sand, which is again sieved after the added material has been thoroughly mixed in, damping being done a few hours before using. As a rule it will be found necessary to ram the surface of the mold fairly hard, and for this reason it is desirable that the sand should be worked as dry as possible consistent with good working, while very adequate venting is also found a necessity as a general thing, care being taken that the vent wire does not actually touch the pattern.

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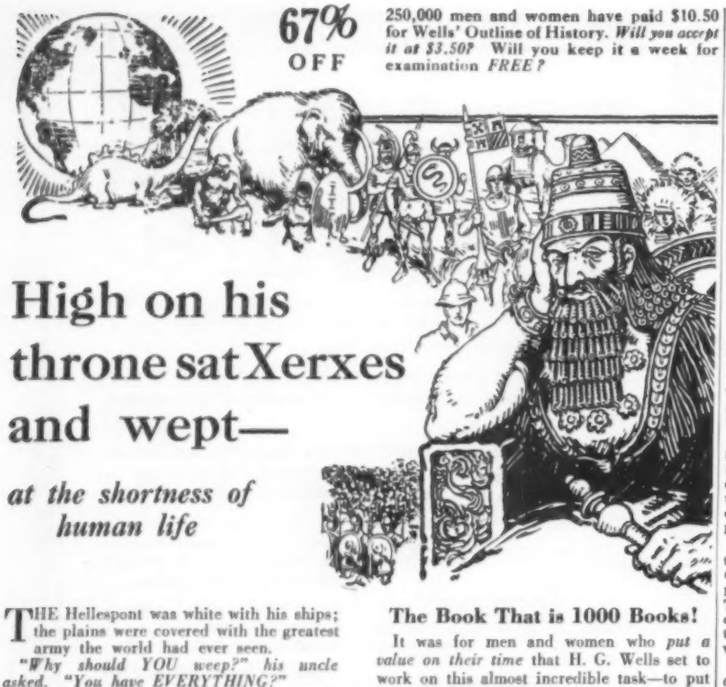

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Miscellaneous Notes

Travel on German Railroads increased this year over last, but Germans are traveling third and fourth class; it is cheaper to use third-class sleeping cars than to live in a hotel.

For Lack of a Railway.—From 60,000 to 100,000 tons of shea nuts are annually rotting along the Gold Coast of Africa; 300 miles of railway would provide a remunerative outlet for these nuts.

Water Power in Sweden.—In 1920 Swedish hydro-electric stations were developing 1,200,000 horsepower. Equipment since added probably brings the total very close to 1,500,000 horsepower.

Smoky London.—The thickness of the London atmosphere is more than half due to her coal-burning locomotives; during the coal strike, oil burners appreciably relieved the situation, but now that the roads have gone back to coal the city has redonned her yellow cloak.

A Seagoing Raft.—A Japanese firm will make an attempt to raft timber from British Columbia to Japan. The raft will be of the Davis type with a superstructure of piled logs strongly laced. Twenty years ago a raft made the journey from San Francisco to China, favored by exceptional weather.

Railroad Signal Experiments made at Waterloo Station, London, favor the "three position light system." The filaments are in the focus of a dioptric lens of white glass; the rays, emerging through greenish-yellow glass, can be seen for over a thousand yards in bright sunlight, and penetrate fog better than white light.

New Observation Cars.—On the Cascade Mountains route between Seattle and Cle Elum, the Chicago, Milwaukee and St. Paul Railway Company has something new in observation cars. The seats are arranged as in a sleeping car, the car is open at the sides above the seats, and there are glass windshields between each section, with an uncovered space at each end of the car.

Dust Spraying for Coal Mines.—From the *Canadian Mining Journal* we learn that in Westphalia a hand-spraying device consisting of a hopper-shaped bucket filled with stone dust and carried on the shoulders is used to spray mine roofs and sides otherwise inaccessible. A trailing connection to a compressed-air pipe furnishes the power; the bucket has a long spout to direct the spray, and an injector sucks the dust from the bucket and delivers it with great force.

High-Altitude African Railroad.—The British government has awarded contracts for the construction of a railroad from Nakuru to the Uasingisu plateau north of Victoria Nyanza, which will attain the greatest altitude of any railway of the British Empire; its highest point will be more than 9000 feet above sea level. The road will cost $10,000,000, and may later be extended into Uganda, connecting the port of Mombasa with the Cape-to-Cairo route.

Fleet of Oil Burners Planned.—The Canadian Chamber of Commerce announces a plan, nearly completed, to run oil-burning steamers on a four-day schedule between England and Canada. There will be 8 vessels of 50,000 tons each, carrying 600 first-class and 3000 second-class passengers, and making 26 knots. The service is later to be extended to all parts of the Empire, making it possible to go from Liverpool to Sydney via Halifax and across Canada by rail in 20 days; it now takes 30 days.

The Toll of Industrial Accidents.—At the convention held in Chicago last September, S. J. Williams, secretary of the National Safety Council, gave the annual loss due to industrial accidents as $1,000,000,000. The wage loss is about $853,000,000, the surgical, hospital and administrative expense adding $161,000,000 to the appalling bill. A New Jersey representative told of the progress made by the Department of Labor of that State in safety education and the enactment of better industrial laws.

Scientists in the Cordilleras.—A Swedish commission, aided by the Peruvian government, is studying little-known regions of the South American Cordilleras. The glacial features of the Sierra section south of Oroya were investigated; the expedition then descended the Perene on rafts to its junction with the Ene; returning, fossils were found in the Pangoa valley. Thence the party went to the San Rafael Lake district of Chili, intending to ascend a glacier to study the inland ice. The ethnology of the Indians also yielded interesting material.

Farm Implements in 1920.—The United States manufactured farm implements to the value of $537,000,000; gas tractors accounted for a third of the total—203,000 of them, valued at $193,000,000; then there were 1,000,000 plows with a value of $40,000,000, 225,000 wagons valued at nearly $25,000,000, and 412,000 haying machines worth nearly $25,000,000. These summaries were made by the Bureau of Public Roads from the detailed reports of 583 manufacturers, and at least 99 per cent of the entire industry is covered by the figures.

The Sirocco Fan.—This fan, invented by Sir Samuel C. Davidson to dry tea, now finds its most important application in the ventilation of ships and for forcing draught in the stokeholds, though subways and theaters also use it. The objection to the common propeller fan, having different points along the blades moving at different speeds, is in the sirocco fan obviated by using a ring of blades all moving at the same velocity. The moving part is cylindrical, taking in air at the center and passing it through curved slats at an efficiency three or four times that of any other fan.

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Notes and Queries

The Notes and Queries column is maintained for the benefit of our readers who desire information on subjects germane to the scope of the paper, together with technical formulas and similar information. Matters requiring profound research or searches in a library cannot be undertaken. In connection with Notes and Queries proper, we maintain a "Service Bureau," which is able, in nearly all cases, to supply addresses of manufacturers whose articles have sufficient novelty and merit to be illustrated in the news pages of this periodical. Correspondents are requested to write their inquiries in all cases, making the subject of the letter entirely separate from the correspondence relating to patents, subscription, books, etc. This will greatly facilitate the answering of these questions, which in many cases have to be referred to experts. The full name and address should always be given. Our full "Hints to Correspondents" will be gladly mailed on request. All letters are answered by mail and only a very few of them can be printed in the limited space at our disposal.

(14371) R. L. J. asks: Can ice go in temperature below 0° C.? For instance, could it be at 0° F.? A. If a piece of ice is put into a place where the temperature is zero, it will soon come to that temperature and be also at zero. Ice is a solid and has the same properties as any other solid. It can be heated and cooled just like any other solid. Of course it cannot be heated above its melting point. Neither can any other solid. Iron melts when its melting point is reached. So too does a wax candle, and everything else. Each solid has a melting point, and at that temperature it changes to a liquid. The only peculiarity of ice is that it melts at a low temperature. But mercury melts much lower, at 40 below zero F. and alcohol melts at 200 below zero. Yes, ice cools like any stone, and the other day when the mercury was down nearly to zero here a piece of ice stuck to the fingers just as a very cold piece of iron would do at the same temperature. There is no doubt that ice can be cooled below its freezing point. It is not a good conductor of heat and would not cool very rapidly, but give it time and it can be cooled to any degree.

(14372) R. L. says: Some thirty years ago the so-called "Pharaoh's Serpents" were sold on the street in little boxes. A. This article has not been sold recently, but is an interesting chemical novelty. These serpents are little cones of sulfocyanide of mercury, which, when lighted, give forth a long, serpent-like, yellowish-brown body. Prepare nitrate of mercury by dissolving mercury dioxide in strong nitric acid as long as it is taken up. Prepare also sulfocyanide of ammonium by mixing 1 volume of sulfide of carbon, 4 volumes of a strong solution of ammonia and 4 volumes of alcohol. This mixture is to be frequently shaken. In the course of about two hours the bisulfide will have been dissolved, forming a deep red solution. Boil this until the red color disappears and the solution becomes of a light yellow color. This is to be evaporated at about 80° F., until it crystallizes. Add, little by little, the sulfocyanide to the mercury solution. The sulfocyanide of mercury will precipitate; the supernatant liquid may be poured off, and the mass made into cones of about one-half in. in height. The powder of the sulfocyanide is very irritating to the air passages, and the vapor from the burning cones should be avoided as much as possible. To ignite them, set them on a plate, or the like, and light them at the apex of the cone. If you have had little experience in chemical manipulation it would be wise to substitute for this formula the following: The "eggs" may be made of comparatively safe material by the following formula: Potassium bichromate, 2 parts; potassium nitrate, 1 part; white sugar, 2 parts. Powder each ingredient separately, mix, and press into small paper cones. These must be kept from light and moisture. Of course, neither this nor other chemical toys containing substances in the slightest degree harmful if swallowed, should be placed in the hands of children not old enough to fully understand the danger of eating or even tasting unknown things.

(14373) H. G. asks: Is there only one day which is the shortest day of the year, or are there two or more days which have exactly the same length at the shortest period of the year. If it is not too much trouble, could you tell me the dates of the above for the years 1920 and 1921, also the length of day? A. There is but one shortest day in the year, whether you mean the shortest time from sunrise to sunset or the time from midnight to midnight. The shortest time from sunrise to sunset was, in 1920, on December 21st and in 1921 it will be December 22nd. The shortest day time is on the day of the winter solstice, which occurs as we have given above. It is given each year in the Old Farmer's Almanac which is published in Boston and is commonly used in New England. It shifts in the calendar because of the extra day which is inserted once in four years in February. The day from midnight to midnight is shortest, about July 1st, and longest about January 1st.

(14374) A. J. C. says: How can I pulverize mica? A. When mica is heated to redness for some time in a muffle, and then allowed to cool rather quickly, the laminæ become distorted, and the sheets present a silvery-white appearance by reflected light, the mineral losing much of its flexibility. The dust of this whitened mica is used to some extent by the French as silver bronze powder. Mixed with a weak solution of gum arabic, it makes a good silver ink. The powder is sometimes variously tinted by washes of very dilute colored solutions of gums or varnishes. To prepare the glistening powder the sheets of whitened mica are simply crushed, not ground, boiled in hydrochloric acid, rinsed, dried, and assorted to size of laminæ. The finer filaments have a pearly luster, and are made to adhere to semi-softened gelatine and wax to imitate pearl. The silvery powder is used on metals, glass, wood, paper, plaster, tapestry and furniture. It has also been used in calico printing in place of the heavy bronze and glass dust of Lyons fabrics, and for the decoration of china and glassware.

(14375) E. V. W. asks: About 7 or 8 years ago, in the original theatrical production of "Everywoman" a transparent mirror was used, and I am curious to know the chemical solution that was used on the glass to produce the effect of a mirror and at the same time permit of the glass being transparent. A. We do not know what was used for making a transparent mirror in the play to which you refer. It is not necessary to coat the glass with anything to make it reflect a strongly lighted object, such as a person clothed in white, or a brightly lighted room. A plate of mirror glass set at an angle will reflect what is placed at one side and also allow one to see what is behind and beyond the glass. Ghosts are made to appear in this way.

(14376) C. H. M. asks: (a) Two men of equal weight are suspended on a rope run over a single pulley. Is either of them able to move on the rope or does either of them have enough weight to pull against to be able to move? If A attempts to move what effect will it have on B? Does the foot-pounds of work done by A enter into the solution of the problem? (b) Would a cable suspended in the air ever break with its own weight? It would be possible to roll the cable into a roll and tie it to the end of the cable and break it but if suspended in air would not the entire cable be holding up part of the weight of the cable below it? A. (a) In the case which you propose if A gives a sudden jerk upon the rope he will give a motion to B. If he pulls steadily he will not move B. The sudden jerk will overcome the *inertia* of B and move him up a little. The weight of A balances the weight of B. This is easily settled by trial. Try it and demonstrate for yourself. We do not see that foot-pounds enter into the case at all. A does not do any foot-pounds of work unless he moves through some space. (b) Certainly a rope will break by its own weight just as easily as if it is lifting a weight. If it is laid across between two towers the pull of gravity upon it tends to stretch it and break it in the same way as if it were lifting a weight vertically. The pull upon the cable is all of it transmitted to the towers and tends to pull them over. If this pull is more than the rope can stand it will break. One part of the rope does not carry the weight of another part. The whole weight of the rope pulls against the top of the tower.

(14377) M. A. K. asks for formulas for polishing rags which can be made at home. A. (1) Saturate woolen stuff with a solution composed of 3 oz. 4 dr. of Castile soap dissolved in 14 oz. of water; to this solution add 22 dr. of tripoli. Color with coralline. (2) "Serviettes magiques," for polishing articles of metal, consist of pure wool fabric saturated with soap and tripoli, and dyed with a little coralline. They are produced by dissolving 1 part of Castile soap in 4 parts of water, by weight, adding 2 parts of tripoli, and saturating the fabric with it, allowing to dry. (3) In 20 oz. of water dissolve 4 oz. of soap, and graduall/ add 2 oz. of pumice stone or finely powdered emery. (4) Infusorial earth may be used with advantage. Saturate the best unbleached muslin with this paste. Color with a little aniline red, if desired.

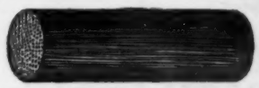
(14378) D. R. R. says: I am interested in the difference between natural and artificial ice. I have heard that natural ice will average about five degrees colder than artificial ice but cannot see how this can be. Also that artificial ice will not store as well as natural ice. A. The chief difference between natural and artificial ice lies in the fact that natural ice frees itself from air in the act of freezing. The water from which artificial ice is frozen is in iron cans and is immersed in the vats of cold brine to be frozen. It freezes over the top and shuts the air in. It also freezes on all the sides and drives the air toward the center of the block of ice. You have doubtless observed the great number of air bubbles toward the center of the block of ice. Artificial ice is undercooled to make it last better in carrying. Natural ice takes the temperature of the air in which it is, as also does artificial ice after it is taken out, if the air is below freezing; but if the air is warmer than that, the ice comes to its freezing point, 32 deg. F. and then melts. There is no basis for saying that natural ice will remain five degrees or any other number of degrees, colder than artificial ice.

The bigger the *Pipe Crank* you are the more I dare you to write me

By Bob Blake

I CLAIM to be the hardest boiled pipe-crank in the world. I've tried every kind of pipe I've ever seen, from corn-cob to meerschaum, including hoity-toity imported ones that cost from a "shilling" to a "pound." I've coughed and sputtered and scorched my tongue until I was blue in the face. I've smoked pipes with wells, and bowls, and machinery, and tubes, and all kinds of "dinguses"—until my disposition cracked under the strain, always dreaming of some day smoking a pipe that wasn't loaded with dynamite and "goo."

THEN I met Jim Irving. He's been fussing with patent pipes for forty years. He probably has made more different kinds of pipes than any other one man in the country. But although pipe manufacturers have sold hundreds of thousands of them, Jim has never been satisfied himself, and so he continued to experiment. Now, at last, he's discovered a real scientific principle of a cool, clean, dry smoke—a principle that I challenge the most skeptical pipe-cranks to pick flaws in!



Here's the carbonized Indian Reed through which all the smoke must filter.

East India Reed

In the East Indies grows a certain kind of reed. This reed is absorbent and porous—has hundreds of tiny "sap channels" clear through. Jim figured that if he could draw smoke through that reed, the hundreds of cool walls formed by the "sap channels" would just naturally cool the smoke and hold the "goo." So he chiselled a hunk off, blew air through the holes, fixed up a pipe to hold it—and then went to it. Later on Jim discovered that the reed had to be carbonized, which gave it the absorbent and purifying qualities of *charcoal*. Well, the idea worked so fine that Jim bent it down to Washington and got the thing patented right away.

Since then Jim has made and sold thousands of these pipes—on approval. Percolator Pipes he calls them. I got one of the first ones made, thought so much of it that I invested in Jim's Company, and here I am—the biggest pipe-crank in the world—selling pipes.

What's more, I'm after other pipe-cranks. You've been stung on other pipes. So have I. That's why I say, try the Percolator Pipe on my no-risk offer.

I'm safe in making this offer because I know how the Percolator Pipe is made, and what it will do. The wonderful East India reed effectively filters and purifies the smoke and holds the moisture. It keeps the tongue-scorching elements out of your mouth! The hundreds of charcoal walls *must* cool, dry and purify the smoke no matter how hard you puff. That's all there is to it. The bowls are the best imported French or Italian Briar Root. The bits are made of solid vulcanized rubber. The bands are sterling silver. And last but not least, we carbonize the inside of the bowl *so the pipe's broken in when you get it.*

Send No Money Now

The only way to prove what I say is to try the pipe itself. So I make you this offer! Don't send me a cent now. Just mail me your name on a postal card or in a letter, or use the coupon below. I'll send you a Percolator Pipe right away. Say whether you want straight, half-bent or full-bent stem. When it arrives pay the mailman $2.50, then smoke your pipe morning, noon and night for 4 days. If your temper raises one degree, if your disposition sours even a mite, if your tongue or throat ever say "quit," shoot the pipe back and I'll send you your money back right away.

If it is not convenient for you to pay the postman, write me on your firm's letterhead or enclose your business card and I'll send the pipe to you, you can then pay me after the 4 days' trial.

Remember, the bigger pipe-crank you are, the more I dare you to write me. He a skeptic. Say "It can't be done." Once me all you please, but make me prove what I've said. Send me your name right away.

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A Wonderful Christmas Gift

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BI—Half Bent Stem

CI—Full Bent Stem

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Send me one of your Percolator Pipes, Style No. ..... I will pay the postman $2.50 for it on arrival—but if I'm not satisfied after 4 days' smoking (full steam on) I'll return the pipe and you agree to refund my money. I promise to give the pipe a red-hot test, but I'm to be the judge.

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Address.....

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W. L. Douglas $7.00 and $8.00 shoes are absolutely the best shoe values for the money in this country. They combine quality, style, workmanship and wearing qualities equal to other makes selling at higher prices. They are the leaders in the fashion centers of America. The stamped price is W. L. Douglas personal guarantee that the shoes are always worth the price paid for them. The prices are the same everywhere; they cost no more in San Francisco than they do in New York.

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(Scien. Amer., Dec. 1921)

Science Notes

A Digest of Everything of General Interest Appearing in Current Literature

Ampere's Centenary.—French electrical engineers are restoring the tomb of the celebrated physicist in the cemetery of Mouthwaite.

Traveling Hospital for Indians.—A motor truck elaborately equipped as a medical and dental clinic is visiting the remote Californian tribes, accompanied by a physician and a dentist.

Lightning Dismembers a Statue.—Lightning has torn off the arms of a statue at Château-Lambert, France, erected as a thank offering after the cholera epidemic of 1854 had passed.

Wealth Vanishing in Smoke.—Every year 33,000 forest fires, involving some 12,500,000 acres of timberland, cost us $20,000,000. Greater vigilance would save much of this appalling waste.

Possible Oil Discovery in Australia.—Very rich oil shales exist in Australia and Tasmania, and wells are now being driven in the hope of striking oil. Gas has been obtained but no oil—as yet.

Who Invented the Friction Match?—A German chemist has made an exhaustive study of this question and concludes that no one person can be considered to be the inventor of the friction match.

Fighting Famine with Swamp Roots.—Samara University hopes, through its discovery of the edible qualities of "awsan," a swamp root, to reduce the suffering in Russia by one-half. Awsan contains 70 per cent. of starch, considerable albumen, and some fats.

Old Clothes for Radium.—To disguise his precious burden an officer of a Colorado radium company brought nearly $80,000 worth of radium to Philadelphia in an old battered fiber suitcase. The precious substance was deposited in the vaults of a trust company on arrival.

"Papering" Melon Fields.—Out in Wenatchee, Washington, they are covering the fields with roofing paper, cutting out round holes for the melon hills. It is found that by this practice all weeds are smothered and there is a 50 per cent. saving in labor for cultivation and irrigation.

Edinburgh Meeting of the British Association.—The September meeting of the British Association held at Edinburgh was of great importance, as science has begun to right itself after the war. The conference was divided into thirteen groups. Over 1,200 visiting members of the Association were present. Prof. Arrhenius was the star scientist.

First Appearance of the Mastodon.—It would seem, from a recent report, that the true mastodons made their appearance in this country at a much earlier period than was heretofore presumed. One found in Nevada places their existence as early as the Middle Miocene. Previously the earliest finding was from the Middle Pliocene.

Our Gifts of Tree Seeds to Europe.—Great Britain used up 1,500,000 acres of timber during the war. In 1919 we made England a present of 25 million tree seeds for reforestation purposes; the American Forestry Association is asking what disposal was made of these seeds. France was given an equal number of seeds of evergreens, Oregon pines and Weymouth pines.

Beavers Dig to Freedom.—The colony of beavers at the Zoological Park of New York have tunneled under the foundation wall and escaped to the upper reaches of the Bronx River. One was ignominiously captured under a wash-boiler. Many keepers camped on the trail of the others, but the "call of the wild" proved to be too civilized and the beavers returned to their home in captivity and they seemed glad to be home.

Camouflage Unmasked.—The gun-concealing painted shrubbery of the Germans is rendered useless by taking advantage of the fact that real leaves reflect red and green light, the painted foliage green light only. Viewed through a "light filter" the difference is apparent. The countermove was to use such pigments in camouflage as would produce the red-light reflection. This was done, and the battle of the scientists goes merrily on.

Amundsen to Try Again.—Early next spring the schooner "Maud," now repairing and outfitting at Seattle, will again be driven northward in an attempt to prove Amundsen's theory that, by taking advantage of the right current, a vessel frozen in the ice will drift across the Polar Sea in less than five years. Twice his efforts have been unsuccessful, and in the second venture a propeller was broken. This time the ship will carry two airplanes furnished with sleds.

Taking the Rattle Out of the Rattlesnake.—In a combat between a diamond rattlesnake and a blue racer, the latter was victorious over his more virulent adversary. During the fight, reports a writer in *Science*, the racer was badly bitten by the rattler; whereupon the former worked his way to a patch of weeds and bit into the stems extracting the juice, after which he returned to renew the fray. This peculiar performance was repeated in a short time, when the racer again returned and destroyed the rattlesnake.

Blinding the Motion Picture Actor.—An English committee traces injuries to the eyes of actors to the use of open arc lights; they discovered no permanent damage to sight, but reported that unscreened arcs are not only unnecessary, but actually give less satisfactory results. The Association of Kinematograph Manufacturers has promised the Ministry of Health to enforce the use of filters in their studios. There is much room for scientific research as to the best type of lamp.

How Flying-Fishes Fly.—Some highly interesting observations on flying-fishes have been made by Dr. E. H. Hankin in the Arabian Sea. In still weather the length of a glide was about a meter, with considerable lateral instability; in a light wind this was increased to from 200 to 400 meters. A resemblance between the wing action of soaring vultures and the fin action of the fishes was marked. In both, the wing or fin is inclined upward, the outer part at a higher level than the base, in slow-speed flight, while both show a downward inclination in flight at high speed.

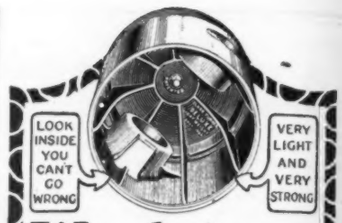
Poroscopy and Graphometry.—As if the way of the transgressor was not hard enough already, Dr. Locard, a world-wide authority on criminal identification, has elaborated two new plans which seem to have been received with favor in the French criminal courts. In "poroscopy," Dr. Locard considers the number, form and position of body pores remain the same throughout all one's life. The impression of the pores, in his system, is colored by chemical vapors or very fine powders so they may be photographed with the aid of a microscope. Graphometry consists in the theory that handwriting shows always a certain relation in size between letters and unmistakable characteristics in form, particularly of loops.

Conservation of Vanishing Species.—It is urged upon all biologists to exert "a more serious effort to rescue a few fragments of vanishing nature," including all forms. It is pointed out, through the medium of *Science*, that the appalling rate at which our native flora and fauna are disappearing is obvious to all except those workers whose outlook is bounded by the walls of their laboratories, and that the situation is accepted by these latter as more or less inevitable. That biologists, above all others, are in a position to "appreciate the loss of a single species or of natural associations of species" is patent. They are, furthermore, in an advantageous position to bring out by propaganda and with the weight of authoritative counsel the value of this conservation. Toward the furtherance of this end, a national organization has been proposed.

"Blind as a Bat" Loses Significance.—An experiment conducted lately by English investigators points strongly to the conclusion that bats avoid colliding with objects during their swift nocturnal flights, not so much by their sense of sight as by their acute hearing. A number of these animals were blindfolded and released in room crossed with many wires and having in one of the walls an aperture just ample enough to enable the bats to escape into an adjoining room. They easily avoided the wires and flew through the holes without coming in contact with the partition. It was discovered that while flying they emitted a note almost inaudible to the human ear; and from this it was presumed that they perceived sound vibrations which were reflected from the obstructions, and were guided thereby.

Mount Everest Baffles Explorers.—The British expedition which is attempting the conquest of Mount Everest in the Himalayas, the world's highest peak, has completed its explorations to the north and west of the mountain without discovering a single practical route to the summit, it was announced in a cable dispatch from Simla dated August 27. Some hope is still entertained, however, that a route may be gained on the northeast flank of the great mountain, and when the monsoon abates another effort will be made. If the summit cannot be attained this year it will probably be reached next year. Meanwhile the headquarters of the expedition has been moved toward Kharta, upon which point the further effort will be based. The present expedition has surveyed about 10,000 square miles of territory on and adjacent to Mount Everest.

Fabre.—The passing of October marks the sixth anniversary of the death of Jean Henri Fabre, whose chronicles of the lives and habits of the insects have been, perhaps, more effective in creating a love for those lowly animals in the popular mind than the combined writings of all other entomologists. His literary technique was of the very highest order. This was the real secret of his fame—a belated fame, however, for living until the advanced age of ninety-two, it was not until the closing years of his life that he tasted the fruits of his labors. As one peruses the thrilling pages of his intimate life histories, the tremendous genius of the man forcibly impresses itself on the reader; at one stroke of his pen he has interpreted with scientific accuracy the ways of his animals, and has made those ways as dramatic and as interesting as the affairs of humans.



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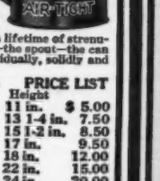

Made of 16-18-20 and 22 oz. best clean 100 per cent pure copper. No solder inside; all solder outside. The can screw is five inches in diameter. Large enough for hand, easily cleaned. These cans are built to last a lifetime of strenuous wear. Every part—the spout—the can—screw, etc., is individually, solidly and perfectly fitted.

SPECIFICATIONS

Size	Diameter	Height
2 gal.	8 1-2 in.	11 in.
4 gal.	11 3-4 in.	13 1-4 in.
6 gal.	12 1-4 in.	15 1-2 in.
8 gal.	13 1-4 in.	17 in.
10 gal.	14 1-4 in.	18 in.
15 gal.	14 1-4 in.	22 in.
20 gal.	18 1-2 in.	24 in.
25 gal.	19 1-8 in.	26 in.
30 gal.	20 in.	30 in.
50 gal.	25 in.	35 in.

PRICE LIST

$	5.00
	7.50
	8.50
	9.50
	12.00
	15.00
	20.00
	25.00
	30.00
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Civil Engineering Notes

Abstracts of Important Recent Papers and Published Articles

The Disposition of Old Ties is an item of no small inconvenience and expense to the railroads. Increased labor costs makes it no longer possible to load them and haul them into terminals for engine wood. One solution has been found, applicable apparently in any scantily wooded section. It is found that farmers and others near the right of way are willing to haul them away for fuel, and usually to perform some service in return, such as plowing fire guards, giving right of way for snow fences, etc.

A Tunneling Machine of new design has just made its appearance. While there is nothing new in the idea of tunneling machines, the present scheme is decidedly novel. It comprises a boring head and a rotating tail arrangement by means of which the lining is placed. At present the machine is being experimented with in Philadelphia with what are said to be satisfactory results. Eight men operate the experimental machine. As it advances and bores its way through solid rock, the rotating tail places the lining in the tunnel, thus finishing the job in one operation.

The Resistance of Redwood to Rot is demonstrated in a remarkable fashion by the record of some water pipes of this material which has recently been put forward. These pipes were not of the stave type, but were actually bored from the logs. They were in use for sixteen years on the underground water system of a western ranch. This system was torn up, and the pipes piled in the open, where they remained for ten years more, weathering in the sun and rain. They have recently been examined with the view to putting them in service again, and are found to be in a condition fully justifying this step.

Hydro-Electric Plans in Ceylon.—Surveying and plan-drawing in connection with the Aberdeen-Laxapana hydro-electric scheme have progressed sufficiently to enable a fairly accurate estimate to be made of the cost of the work up to and including the generating station. The survey and location of the high-tension transmission lines has begun. To carry out the scheme on a less expensive basis it has now been decided to develop the Kehelgomu-oya first, and bring in the water of the Maskeliya-oya at the third stage. This will not interfere with the final output. The report of Mr. Bolton, who was sent to Ceylon by the British consulting engineers, shows that cyanamide could be produced in the island at less than the present price of the imported article.

Drainage of Zuyder Zee.—At the Inland Shipping Congress held at Rotterdam recently the drainage of the Zuyder Zee formed the most important subject of discussion. It was pointed out that the drainage would necessitate the construction of a number of new canals. One speaker pleaded that the building of new villages and factories in the polders should not be left to mere chance. Villages with churches should be built near the canals, but industrial works near the dykes. Such an arrangement would prove of advantage to shipping, and would prevent any pollution of the polder water. A number of the waterways connecting the Zuyder Zee ports are to be preserved, but wherever polders form a continuation of the existing land, new harbors will have to be made.

Motor Transport in Syria.—Since the French occupation of Syria great attention has been paid to roadmaking, and good results have been obtained. The Lebanon especially has a large extent of good driving roads. His Majesty's Consul-General at Beirut says that conditions are therefore favorable for motor transport. There has been a considerable import of motor-cars during the past year. American cars greatly predominate owing to their cheapness. Their lightness and power suit them for the rough roads and arduous climbs. British low-priced cars are not sufficiently powerful for the climbing, while the higher-priced ones are too dear for the market or too heavily built. Owing to the small carrying capacity of the Damascus Railway under present conditions and to the high rates, merchants even now find it cheaper to transport goods to Damascus by road. Lorries and vans are also in use in Beirut itself and in the coastal regions.

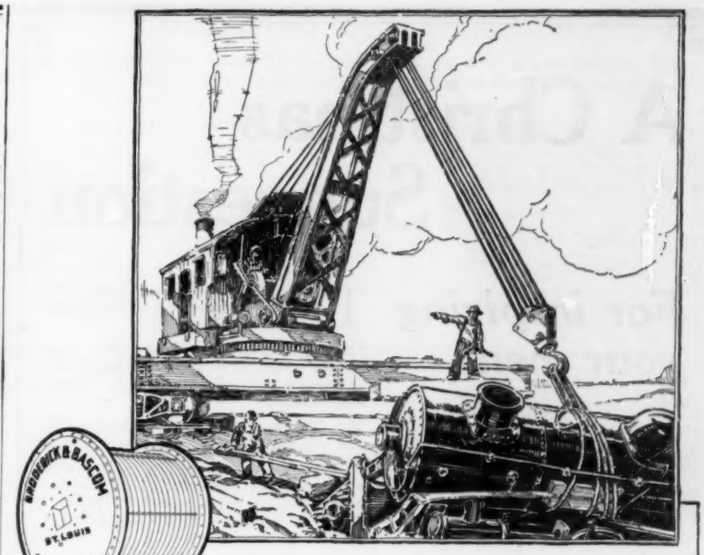
Anchor Tie Plates.—Safe track is the first requisite for safe and profitable railroading. The only safe track is the track anchored to resist all forces that tend to make it creep or move in any direction. According to a Middle West manufacturer, his anchor tie plate with a special key absolutely prevents the spreading, creeping or lifting action of rails and prevents even the least movement at such critical points as interlockings, crossings, radial tracks or insulated joints. Not only is the rail held from creeping both ways, but the expansion distance between rail ends kept as can only be done by two-way anchoring of the rails. The holding of the rail flange by the lip of the plate on one side and by the key on the otrer gives a rail base width equal to the length of the plate. This enormous advantage, so it is claimed, is secured only by this plate. The maintenance of plate is slight, nor does it require that ballast be distributed to protect it. The key prevents the "necking" of spikes. Spikes are always driven straight and are always straight when withdrawn.

Ship Concrete in Germany.—German engineers are studying concrete for ships with a view to getting a light, strong and impermeable material, we learn from a contemporary. As a result, some experimenters are recommending adding to portland cement 10 to 25 per cent pulverized calcined limestone and 20 to 35 per cent of a pulverized silicate of magnesia, preferably white talcum, rich in silicates, and containing no chlorides. To this carefully prepared mixture some of the well-known porous ingredients are added, and then the substance is stored in a dry and airy place. Thereafter it is used for preparing the concrete in the same way as ordinary cement would be used, but in a richer proportion. The concrete obtained therefrom, by casting or ramming, is light, waterproof, elastic, acid-proof and tough, is reported to possess the good qualities of concrete for shipbuilding purposes in a higher degree than concrete made of pure portland cement. A great deal of experimenting is going on both in Germany and Austria in concrete ships and barges, particularly the latter for use on the inland waterway systems.

Detroit's Proposed Bridge.—Development of the plans for the Detroit River bridge to connect Detroit and Windsor, a project that has been under consideration during the past two years, has progressed far enough to put into concrete form some of the outstanding features of the proposed structure in a recent issue of *Engineering News-Record*. We learn that a span of 1803 feet, from center to center of towers, will be required, and for this purpose a suspension bridge with unloaded backstays, carrying two decks for separate accommodation of railway and highway traffic, has been designed. The plan has been adapted to the requirement of construction in two stages, the highway deck to be constructed first and the railway deck to be added later, together with the cables and extra stiffening-truss capacity required to take care of it. The towers of steel consist each of four posts in the vertical planes of the four pairs of cables (one pair to each stiffening truss). A sag ratio of one-tenth has been adopted, with stiffening-truss depth one-fiftieth of the span length; a sag ratio of one-ninth and a truss depth of one-sixtieth are being investigated for economy, deflection and general appearance of the structure.

Quick-Hardening Cement.—In the course of the world war, states Edwin C. Eckel in *Engineering News-Record*, a cement of very remarkable type and properties was put into use by the French for special military purposes. Its high technical value, in certain limited fields, is such as to make it advisable to discuss briefly its characteristics. As an introductory summary we may say that it is lime aluminate, differing from normal portland cement in the almost total absence of silica; that it is prepared by actual fusion, not by mere clinkering; that it is almost white in color; and that it will harden with such rapidity as to make a good heavy-gun platform within 24 hours. So far as cost of manufacture is concerned, the fused cement can obviously be made at least as cheaply as a normal portland. Its uses will be determined, then, not by cost, but by its special characteristics, which give it value in certain fields of work, but limit its use in other lines. Considering the composition of the fused cement, its most remarkable property, perhaps, is its resistance to the decomposing effects of sea-water and similar solutions, for until this Lafarge cement was introduced there was a tendency to ascribe the breaking up of portland cement in sea-water to its content of alumina, and to search for cements low in alumina.

Novel Steel Sheet Piling Cofferdam.—In developing additional horsepower for the hydro-electric plant of the Niagara Falls Power Company, to meet the needs of the War Department, a great many obstacles were encountered and subsequently overcome by the engineers of a steel sheet piling manufacturer. In the construction of the forebay, it was necessary to build a cofferdam that would restrict the flow of the hydraulic canal as little as possible, so as not to interfere with the operation of Station No. 3, as it was imperative to keep all the old plants running to their utmost capacity during the Summer and Fall of 1918. This cofferdam was located along the old west wall of the canal basin, which previous to its removal acted as a natural cofferdam for the required excavation. After a thorough analysis of the different methods of construction under consideration, the engineers of the power company decided that a narrow cofferdam composed of a number of cells or pockets was best fitted to meet their requirements. The cofferdam finally adopted, consisted of eighteen oval-shaped pockets formed with straight-web piling, varying in length from 16 feet to 24 feet. In constructing the cofferdam, timber trusses were first built and floated to position along the old concrete wall, after which timbers shaped to fit the outside of the pockets were fastened upon the cofferdam side of the truss. Templates made of two thicknesses of 2-inch plank conforming to the inside of the pockets, were then floated into place and the steel sheet piling was assembled around them and against the truss. As soon as one pocket was assembled, the piles were then driven with a light steam hammer through any loose rock which might lie on the bottom of the basin. This driving also caused the ends to fit as closely as possible in the solid rock. After the driving was completed, the driver examined the pocket and closed any openings that were found to exist between the piling and the rock, with bags partly filled with concrete.



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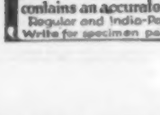

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Britain's New Battle Cruisers

(Continued from page 90)

weapons. Had military and technical considerations alone prevailed, there is little doubt that the new British battle cruisers would have been armed with 18-inch battteries. But the Cabinet, according to rumor, opposed such an armament on the ground that it might be construed as a challenge by other Powers, notably the United States and Japan, and inaugurate a new international competition in "tons and guns"—a development which British statesmen are particularly anxious to avoid. This is probably the first time on record that the design of British fighting ships has been influenced by diplomatic considerations, but, looking at the matter in a broad light, few will question the sagacity of the Cabinet's attitude. Japan, at any rate, is known to have designed an experimental 18-inch gun, if she has not actually built one; and as for the United States, it is all but certain that the later capital ships of the current program would have been re-designed for an 18-inch armament had weapons of this caliber been selected for the British battle cruisers.

But the Naval Staff, having been denied the 18-inch gun, was determined that its new ships should not be inferior to their foreign contemporaries, and therefore resolved to introduce the 16-inch model, which had previously been adopted for the capital ships of the United States and Japan.

The New 16-Inch Gun

As shown in Vickers' list, the new gun is 741.25 inches in length, the bore being 720 inches long, and the total weight 117 tons. The armor-piercing projectile weighs 2240 pounds, and is fired with a muzzle velocity of 2450 foot-seconds and an energy of 93,230 foot-tons. With an uncapped projectile the penetration of wrought-iron plate at the muzzle, according to the Gavre formula, is 57 inches. The maximum rate of fire is 1.2 rounds per minute. A shorter model of the same gun, 43.65 calibers in length, weighing 107¾ tons, and firing a 2461-pound shell, is also listed by Vickers. In both cases the weight of the projectile, it will be noted, exceeds that of the American 16-inch shell, though the muzzle velocity is less. As mounted in the new ships the 16-inch gun will be capable of elevation up to 35 degrees, at which angle the extreme range will be over 40,000 yards. Apart from the increased range obtainable, the advantage of giving the main guns a generous angle of elevation is that it enables them to keep bearing on the target even though the ship be listing heavily as the result of damage on or below the waterline.

British Adopt 3-Gun Turret

The turrets will be of a new patttern, built up of 15-inch or 16-inch armor on the exposed parts, with a flat roof that will offer no "bite" to descending shell. Each of the three guns in the turret will have independent elevating gear. All the turret machinery will be hydraulic, for although British naval engineers are fully alive to the merits of electricity for this purpose, they still believe in the all-round superiority of the hydraulic system.

The secondary battery will comprise 16 rapid-fire guns of 5.5-inch or 6-inch caliber. Although introduced only six years ago, the 5.5-inch has become popular in the Navy owing to its light weight compared with the 6-inch and its very high rate of fire. The projectile weighs 82 pounds, and is considered sufficiently heavy for the attack of hostile destroyers or submarines. Each of the new ships may carry as many as 12 torpedo tubes, all or nearly all mounted above the waterline. Professional opinion has turned against the submerged tube owing to its repeated failures during the war. Torpedoes fired from these tubes when the ship was traveling at high speed did not run straight, apparently because the sliding bar, or "spoon," failed to protect the torpedo from the lateral pressure of water as it emerged from the tube. Moreover, there were several cases of the bars bending under the strain, and more than one ship had to return to dock-yard to have a buckled torpedo bar withdrawn. For these reasons the modern tendency is to mount torpedo tubes above the waterline, where they occupy much less space and are far simpler to operate.

New "Hoods" To Be Built Slowly

According to present plans, the four new battle cruisers are all to be in commission early in 1925. Their keels will be laid during the coming winter, and the building period is to extend over 36 months. Not more than £2,500,000 is to be expended on the work during the current fiscal year, which terminates on March 31. No credence should be attached to recent rumors that the British Admiralty has a further big program of construction up its sleeve. Future British naval policy will, of course, be influenced by the outcome of the Washington Conference, and it is a fact that the people of Britain fervently desire a happy issue both on political and economic grounds. Burdened as they are with a heavy load of war debts and crushing taxation, they are not prepared to sanction any ambitious scheme of naval aggrandisement which cannot be shown to be absolutely vital to the national safety. It is true that the four-ship program, involving a total first cost of about £30,000,000, has been accepted without serious criticism, but this is because the country realizes that unless something is done at once to replace obsolete material the British Navy a few years hence will have declined to third place and the Empire would henceforth be existing on sufferance.

It may be said in conclusion that the new battle cruisers fall considerably below the ideal cherished by British naval tacticians. Not only has their design, as mentioned above, been influenced by political considerations, but the Admiralty constructors have had to work inside a definite financial limit, which compelled them to keep within relatively modest dimensions. The "ideal capital ship," as defined by Sir George Thurston, Vickers' well-known designer, would be a vessel 932 feet in length, 112 feet broad, drawing 31½ feet of water and displacing 57,000 tons at legend draft. She would have machinery of 200,000 S. H. P. for a speed of 33½ knots, and be armed with a main battery of eight 18-inch 45-caliber guns. Monsters such as this may possibly be afloat in a few years' time, but it is more than doubtful whether the first of them will fly the British flag.

Railway Conditions in Soviet Russia

THE following observations on railway conditions in Siberia and European Russia are from a source which the Bureau of Commerce considers reliable and are of recent experience:

On the main line of the Transsiberian Railway the roadbed seemed to be in good condition all the way. Section hands and trackmen employed under the old régime have remained at their posts, despite arrears in their pay, and have made the necessary repairs in track ballast. Telegraph lines are also in good condition, and fully half the poles have been renewed during the last two years, according to the date marks on them. A number of stops were made en route on account of delays in transportation.

The rolling stock of the railways is in a very unsatisfactory condition, chiefly due to lack of spare parts for repairs. This is especially true of locomotives. The yards in practically every terminal were filled with locomotives that had been junked. There seems to be a large supply of box and gondola cars, although many of them have been requisitioned on sidetracks to house soldiers and in some cases refugees. There is great shortage of passenger cars, and all of them are in bad condition. Hot boxes were very frequent all along the lines on account of worn-out bearings and inferior oil.

Trains are running regularly three times a week from Irkutsk to Omsk, taking four days for the journey, and to both Petrograd and Moscow, requiring from four to five days each. A large number of the passengers on these trains are soviet officials, as it is exceedingly difficult for civilians to secure permission from the authorities to travel. A large number of civilians, however, were traveling with their possessions in freight cars in both directions.

The north route to Perm and the routes from Moscow to Petrograd, Reval, and Riga are in fair condition, but the southern routes to the Urals and many of the others in central and southern Russia have been partially or completely abandoned.

A German commission is in Moscow negotiating for the operation of some of the railway lines.

The following statement of railway conditions in 1921 is summarized from information published in official soviet papers:

Conditions of rail transport have rapidly grown worse during May and June. The number of locomotives repaired during recent months is very low. The program for rail transport has been reduced by 40 per cent, but even this program will not be carried out. Many unfit cars, with broken roofs and bodies, are lying on the tracks awaiting repair which has been ordered.

The rapidity with which the situation grows worse is shown in the following data on cars for the 10-day period, June 11-20, 1921. During that time 413,856 cars were accounted for, excluding tank cars, and were distributed in the main as follows: Unfit for use, 9515, as against 8785 in the previous 10-day period; under repair, 119,884, as against 115,932 in the previous 10 days; used as stores and living rooms, 26,083; in economic trains (presumably for railway needs, construction, repair, etc.), 20,557; in passenger trains, 14,247; in reserve, 523; empty, 51,396; actually working, 170,710, as compared with 172,854 during June 1-10.

In addition, about 13,600 tank cars (decreased during May and June from 15,200) were in operation, carrying crude petroleum and kerosene, etc., from the Caucasus to various southern railways.

The actual use being made of cars in service is shown in the following data on distribution of loaded cars per day during the period June 11-20, as compared with June 1-10: Military transport, 1455 and 1508, respectively; food transport for Soviet Food Commission, 1401 and 1459, respectively; food transport from foreign trade, 411 and 431, respectively; fuel (except petroleum), 3114 and 3181, respectively; in economic through trains, 200 and 131, respectively; in economic local trains, 987 and 1038, respectively; goods for Supreme Economic Soviet, 703 and 803, respectively; building materials, 171 and 189, respectively; various goods, 260 and 303, respectively; under orders of Communist Party, 152 and 113, respectively. It appears that loaded cars decreased in every line except those under orders from the Communist Party, and that the largest number of cars was used in transporting coal and wood fuel, military supplies, food and railway supplies—in the order named.

Russian freight cars carry from 600 to 1000 poods each (9½ to 16 long tons). The majority of cars at present will not load more than 600 poods.

INDEX FOR THE WEEKLY SCIENTIFIC AMERICAN INCLUDING OCTOBER 15, 1921 ISSUE

Note.—Illustrated articles are marked with an asterisk(*). Look for the general subject rather than the supposed specific title of any article. Thus: "Aeronautics," "Automobiles," "Meterology," "Canals," etc., will give related articles much more quickly than by reference to the title of the article.

Lack of space prevents the use of many cross-references.

A

ACOUSTICS, bad, remedied....267
ADVERTISING.
Airways, advertising on.... 72
Photographs, use of.... 68
Show window, psychology of...200
AERONAUTICS.
ACCIDENTS.
Aviation fatalities 58
Bending strength, "ZR-2"....178
"ZR-2," lesson of the....200
"ZR-2," loss of....158
"ZR-2," more light on....267
"ZR-2" wreckage of....*203
CONSTRUCTION.
Control in circling flight....267
Flying boat, new....*167
Foochow, aviation at....215
Handley-Page, new 59
Helicopter, captive *117
Helicopter, Oehmichen 111
Helicopter, secret 215
Helicopters, French 111
Man-driven plane 111
Model basin and wind tunnel....*82
Morane-Saulnier plane 19
Plane that blows itself along..*103
Propellers 159
Survival of fittest....*167
Wings, aluminum 136
DIRIGIBLES.
Airship travel profitable?....214
Frame metal 19
Parseval "PL-27" *233
Tomorrow's airships 80
"ZR-2" airship and shed....*160
FLIGHTS, ETC.
Altitude record 267
Deutsch de la Meurthe cup.... 59
Grand Canyon explored.... 3
Height record 159
North Pole flight....215
Records, new 266
Worth-while flight 111
GENERAL.
Advertising on airways 72
Altitude cockpits 19
Commercial flying safe?....111
Exposition, Paris 159
Fog devices, new....159
French air port....215
French radio sets....267
Glider flights, studying....*262
Government control 215
Hangar door, new type....*101
Hangar, largest tent....*261
Information for aviators....111
London-Paris flights 59
Pumping plant, airplane....159
Reval-Stockholm service 267
Safety factor, indicating....*277
Service, daily, to Capital....215
Tell-tales, aviator's *274
MILITARY.
Aerial bombing limitations.... 2
Bomb, 4000-pound 111
Bombing, and naval policy.... 90
Bombing a U-boat *27
Bombing, naval, results of.... 3
Bomb or battleship?.... *4
Depth-bombing from air....*92
Mine-laying by aircraft 19
Planes with little planes....267
Weapons at sea....*17, 25
MOTORS.
Engine, 1000-horsepower ...111, 267
Multi-engined geared power 215
Three engines in one....*259
AGRICULTURE.
Corn harvester, platform....*83
Irrigation and drainage....127
Machine that clears land....*77
Pests, or benefactors?....251
Plant disease, carrying.... 7
Seed-tester, rag-doll....*7
Shock loader *23
Soil acidity 279
Synthetic agriculture 81
Tractors and trucks....3, 187, 268
Water, how much, for crops?..*224
AIRCRAFT. See AERONAUTICS.
ALARM to foil hold-ups....*226
ALCOHOL, INDUSTRIAL 164
ALCOHOL, SYNTHETIC 136
ALUMINUM.
Aluminum dust explosions....150
Aluminum ore analysis.... 39
New process of manufacture....143
Solders for aluminum....195
AMUSEMENT devices, new....*269
ANIMALS.
Exhibits, behind the....*254
Rabbit drive, Idaho's....*119
Snakes as source of profit....251
Zebras in New York....*276
ARCHITECTURE. See BUILDING CONSTRUCTION.
ARMAMENTS offset reparations...142
ARMY. See NATIONAL DEFENSE.
ASHES, HEAT FROM.... 59
ASTRONOMY.
COMETS.
Comets 16
Mysterious visitor *168
GENERAL.
Astronomical postcards 195
Effect of earth on sun....195
Gegenschein in London.... 39
Heavens month by month
*12, *100, *168, *240
Interference methods 179
Meteorite fall 143
Meteorite records, early.... 59
Meteor observers 91
Novelty in publications....231
MOON.
Lunar features 231
Lunar photographs 231
Pickering's observations 159
OBSERVATORIES.
Novel observatory 195
PLANETS.
Jupiter, clouds on.... 91
Mars, photographs of 195
Planets month by month, *12, *100, *168, *240.
Rhea, eclipse of....143
Saturn's rings 179
Venus' atmosphere *240
Venus, rotation of....159
STARS.
Barometric effects 91
Binary, remarkable 91
Catalogue of double stars....231
Clusters and nebulæ....*46
Diameters, stellar 91
Larger than Betelgeuse....231, *240
Nebulæ 39, *100
"New" star, what is a....231
Nova Aquilæ No. 3....195
Novæ observations 39
Photographs, defect in.... 39
Proper motion figures....179
Stars of composite spectra....102
Taurus, dark nebula in....195
True north by stars.... 91
SUN.
Prominence, high 39
Sunspots without telescope 179
ATHLETICS, the science of....256
AUTOMOBILES.
ACCESSORIES AND SUNDRIES.
Carburetor, first aid to....*122
Cleaner, vacuum *69
Differential, new-position....143
Grease dispenser, pneumatic..*262
Headlight control, handy....*30
Instrument board 143
More miles to gallon....*30
Oil gun 195
Rustproofing process 91
Spotlight for closed car....*262
Tank, combination *69
Towing wrecked car....*101
ENGINES.
Heat of the engine....195
Losses in motors 28
Molybdenum steel *62
Pre-heaters, American 91
Rocker arms 195
Trouble-locating device *14
V-types, narrower 91
FUELS. See FUELS, and MINES AND MINING.
British gas distribution....143
Fuel comparison 268
Gasoline mixed with alcohol....195
Gas pump, square deal....*226
Natural gas gasoline.... 91
Reatomizing devices 234
GENERAL.
British roadside breakdowns....*73
Careless design, mark of....143
Danish motor car census....195
Friction drive 195
Garage, angular *261
Missing spark, locating....*242
Nuts, loose 195
Other side of picture....194
Out of sand with chicken wire..*43
Radio-controlled automobile....*253
Something new under the sun....266
Stolen car industry 195
Use of horses in cities....138
Wheel alinement indicator....*103
Wheel, drop-forged 143
PLEASURE CARS.
Fans for limousines.... 19
Oldest auto still running.... 39
TIRES.
Old tire, new use for....*14
Puncture plant protection....*183
TRACTORS.
Fuel comparison 268
TRUCKS.
Armored truck for payrolls....*138
Ash hauling cost reduced....*206
Brakes, front-wheel *206
Departure, a new *223
Gearset, compound, design....*50
Motor bus: a step ahead....*138
Motor-driven commercial vehicle.
*50, *138, *206
Mystery picture *163
Pneumatic or solid tires?.... 69
Trailer, four-wheel *50
Trailers, Chicago favors....170
Trucks of long life....262
Wheels, laminated wood disk....138
USES OF.
Bus, six-wheel 3
Hearse, gasoline 91

B

BACTERIA, COUNTING *29
BALLOONS. See AERONAUTICS.
BAMBOOS for the market....*102
BATTLESHIPS. See WARSHIPS.
BEAR ISLAND'S HISTORY....231
BELTS, leather, cement for....140
BIOGRAPHY, including OBITUARIES.
Byrn, Edward W....257
Crocker, F. B.... 75
Curie, Mme. 3, 19, 25, 267
Hart, Amos W....257
Hewitt, Peter Cooper....179
Klein, Julius 59
Lippmann, Gabriel 267
BIOLOGY.
Animal tissue, undying.... 10
Bacteria, counting *29
Parasites, animal 271
BIRD-CAGE PROBLEM 97
BIRDS.
Flight, speed of....149
How fast do they fly?.... 18
Pigeon's record flight....251
Velocity of flight....165
BOILERS, CLEANING *67
BOMBING. See AERONAUTICS.
BOMBS, TEAR, and mobs....*197
BOOK OF TAPA.... 3
BOTANY. See PLANTS.
BOXES, strength of 235
BRIDGES.
Bridge building record....*220
Bridging the Delaware....*8
Granite Gorge bridge....*203
Hudson river pontoon bridge..*109, 110, 117
Nickel-chrome steel bridge.... 75
BUILDING CONSTRUCTION.
Arches, the truth about....*77
Architecture, succeeding in.... 64
Brick walls: something new....*30
Cathedral catastrophes 194
Frame, one-piece, welded....*101
Home building simplified....*78
House building, concrete.... 75
Munition-box houses *67
St. Paul's, saving....*113
Shutting out eyesore *23
Stresinger, Berlin's *13
Slag, blast furnace....278
BUSINESS. See INDUSTRY AND TRADE.

C

CALENDAR REFORM 159
CANALS.
Barge canal: State's duty.... 38
Barges, self-propelled *129
Cape Cod canal.... 3
Panama canal investigation....111
Panama canal water supply...*157
Rhine, canalization of.... 75
St. Lawrence project....127
CANDLE, A LARGE 195
CERAMICS.
Ancient art in modern dress...*120
Glazes, colors for.... 28
Modern research 72
CHATEAU-THIERRY refought 267
CHEESE, 12-ton 143
CHEMISTRY.
Chemical Industries Exposition.195
Coöperative analysis 188
Elements: electronic classification 96
German chemists active 143
Laboratory vessel *262
Mixing liquids by machine....*275
Progress of applied chemistry..188
Rôle of chemistry, the....237
Service of the chemist...28, 136, 188
CIDER, learning things about.... 63
CLOCKS, detached escapement *115
COAL. See FUELS, and MINES AND MINING.
CONCRETE. See also BUILDING CONSTRUCTION, ROADS, etc.
Effects of fire on concrete....223
Mixer, centrifugal *269
Pipe, concrete 220
Test blocks, molds for....*235
CONVEYOR for ships....*235
CORK, STORY OF....*270
CORRESPONDENCE, 11, 45, 65, 81, 97, 133, 149, 165, 185, 201, 219, 257
CRANE, MOTOR 14
CRANE, YARD, crawling....*43
CRYSTAL DESIGNS, producing..*205
CURIE, MADAME. See RADIUM.
CURVES, LAYING OUT....*121

D

DAMS.
Movable dam 75
Multiple-arch, cost of.... 11
Water-filled hose as dam....*49
DEATH VALLEY transportation..*232
DICYANIN 180
DISARMAMENT. See NATIONAL DEFENSE.
DIVER from biological viewpoint...280
DIVINING ROD 214, 219
DOCKS. See HARBORS.
DOG'S CURE beautiful....*153
DOVER patrol memorial....*153
DRIVER, TEMPLE *61
DYES AND DYEING.
Anthraquinone 136
China, dyes for....212

E

EARTH'S MOVEMENT, showing..247
EDUCATION.
Rural schools, New York's....267
University population 3
EGGS: breakage 133
EGGS: white yolks 65
EIFFEL TOWER 75
EINSTEIN. See RELATIVITY.
ELECTRICITY.
ELECTRIC LIGHT.
Biggest lighting fixture....*217
Bringing lamp to cleaner....251
Bulbs, life of 262
Highway, illuminated 230
Industrial lighting 179
Lamp facts 127
Night lamp 91
Pintsch lamp 39
Platinum substitutes 91
Sign lamp, new....251
Switch, automatic 267
MISCELLANEOUS.
Ammeter, simplest form....*189
Atmospheric, for power.... 19
Basalt as insulator.... 75
Brush, self-contained....*103
Galvanometer, vibration *115
Generator, largest 231
Heat, concentrated 251
High resistance, new type.... 39
Insulation, synthetic 188
Kitchen hand, automatic *154
Lightning, man-made *268
Motor, built in....152
Motor, burnt-out, preventing....267
Motor, induction 251
Power houses, last word in....*98
Rectifiers, mercury-vapor.... 75
Resistance of human body.... 99
Starters, liquid resistance.... 91
Static electricity 235
Storage batteries 39
Switch, canopy 19
Switch, entrance, shock-proof...267
Transmission at 220,000 volts.... 19
Transmission feat 127
Transmission, 1,000,000-volt....242
Transmission, stretching 230
Transmission towers, steel....231
Transporting current *84
Turbo-generator, reliable 268
Water heaters 231
RAILWAYS, etc.
Rapid transit arithmetic 185
Trackless trolley *27, 231
TELEPHONE.
Cable, longest 91
Cable, New York-Chicago....251
Loud-speaking 'phone *154, 179
Radio telephone *21
Something new *189
ELECTROPLATER, meter for....*226
ELEVATOR, GRAIN 215
ELEVATOR, how, was added....*145
ENAMEL WARE, electricity fires..*204
ENGINE, DIESEL, ashore.... 85
ENGINEERING.
Award, John Frits medal.... 90
Hongkong's projects 143
Profession, new *196
Temple driver *61
ENGLISH, TECHNICAL 178
ERASER, POWER-DRIVEN....*31
EUGENICS, our latest science....273
EXHIBITS, BEHIND THE....*254
EXPLORATION.
Arctic, MacMillan starts for.... 75
Explorers disagree 159
Graham Island 3

F

FABRICS, PROOFING 136
FARMING. See AGRICULTURE.
FENCE MAKERS, tools for....*23
FERRIES, something new in....*37
FERRYBOAT, new type....*193
FIELD GLASSES, spectacle....*242
FINGER PRINTS and paintings...231
FIRES AND FIRE PREVENTION.
Alarm, automatic, for home....*69
Electric fires, reduction of....267
Hose stand for factory....*242
FISH AND FISHERIES.
Alarm for sleeping fisherman.*170
Fish stories stranger than fiction *202
Food fish, saving....*216
Sockeye, saving the....*6
FLOUR: new process.... 13
FLYWHEELS: a few facts....129
FOOD.
Cheese, Swiss, American....*13
Dinner-pail calories....267
Starving in midst of plenty...*116
Vegetable, all-around....*182
Vitamines 28, *76
FRUITS. See also AGRICULTURE, FOOD, etc.
Apple-picking, speeding....*69
Oranges, coloring....245
Orange tree, ever-bearing....143
Protecting by colored light....223
FRUIT STAINS on skin.... 31
FUELS. See also AUTOMOBILES.
Absorption plant....143
Alaska's coal fields....*225
Alcohol *102, 127
Gasoline sources....143
Natural gas, heat values....183
FURNACE, ELECTRIC, new....*229
FURNITURE, all-round piece of...*86

G

GAGE, LIMIT, reading....*31
GALVANIZING, Cadmium in....192
GAS, carbon dioxide.... 28
GAS METER, is, accurate?....*135
GASOLINE. See AUTOMOBILES, and FUELS.
GAS, tear, for riots....111
GAS, water found in....194
GEAR material, non-metallic.... 83
GEOLOGY.
Giant's Causeway....*225
Glaciers, mechanism of....251
Largest crater in world....155
GLASS.
Containers, glass.... 28
Glass from American clays....*21
Tubes, glass, by machine....*222
GLOW-WORM, what makes, glow?
*67, 65
GLUE STAINS....136
GOLF MACHINE....*217
GRAIN SALVAGING by suction....*161
GRAPHITE 59, 143
GRINDING for snagging castings.*154
GRINDING, FACE, TABLE....*189
GUNS. See ORDNANCE and ARMOR.

H

HAIR CUTTER, motor-driven....*189
HAIR TURNING WHITE.... 45
HARBORS, DOCKS, ETC.
Deep water to the Sound....230
Dock, new, for London....111
Piers, city, rapid work on.... 3
HEATING AND VENTILATION.
Fireplace, more heat from....*199
Hot water for country home.... 86
Putting waste vapor to work.... 85
Ventilator and radiator....*14
HEMP, machines for.... 59
HOUSES. See BUILDING CONSTRUCTION.
HOUSES, moving, to clear mines...*95
HOUSEWORK in laboratory....*130
HUMAN MACHINE, TESTING....*187
HYDROGEN, PURE....188

I

ICE MAN, doing away with....*134
INDUSTRY AND TRADE.
Business as usual aboard ship..*95
Engineers of industry, with the, 85, 152
Foreign trade, our....179
Germany's opportunity....127
Noise in factories....96
Overweight, eliminating....*42
Swords to plowshares, from....165
Unemployment situation....179
Vacuum cleaner in factory....152
Wages vs. prices.... 11
Windows, clean, value of.... 85
INKS 28
INSECT POWDER.... 28
INSECTS.
Jeweler and the beetle....*239
Luminous organs....*57, 65
Moths, do, use wireless?....261
Spittle insect....*205
INSPIRATION, the source of....250
INVENTION AND PATENTS.
Inventions new and interesting..*14, *30, *69, *86, *103, *122, *154, *170, *189, *226, *242, *262.
Inventions, recently patented, *32, *51, *104, *172, *208, *244
Inventors, a word to....241
Lampert bill.... 2
Patent decisions, recent.... 69, 226
Patent examination, detail of...178
Patent legislation.... 18
Patents, U. S., abroad....170
Problem and its solution....*146
IRON AND STEEL.
Corrosion, atmospheric....136
French companies combine.... 59
Molybdenum steel....*62
Valve-steel heat treatment.... 3
IRRIGATION. See AGRICULTURE.

J

JEWELER AND BEETLE....*239
JUNK YARD, GIANT....*20

K

KALEIDOSCOPE, collapsible....*122

L

LEATHER.
Science and shoes....195
LENSES, making, in America....*258
LIME 28
LIME industry research....136
LIQUIDS, surface tension of....*14
LITERARY COMMENTATOR.... 90
LOCOMOTIVES. See RAILROADS.
LUMBER. See also TREES AND FORESTRY and WOOD.
British Columbia's trade....127

M

MAGNESIUM, METALLIC....189
MAN-TESTING laboratory....*187
MATERIALS, awkward, handling.*122
MEDICINE AND SURGERY.
Dissection-work projector....217
Hospital, our floating....*68
Starving in midst of plenty....*116
Summer sneezer.... 45
Sun baths, revolving....*170
Surgery, old Peruvian....*151
Vitamine determination.... 28
MERCHANT MARINE.
Better merchant marine outlook 58
Cargo, sucking, out of ship....*131
Charthouse, lighting.... 3
Compass, radio....*89
Crews, American.... 3
Engines, semi-Diesel....259
German ships up-to-date....111
Loading at sea, hose for....*277
Maritime policies.... 3
Motor clipper....*162
Package conveyor....*235
Salvaging equipment, new....*41
Shipping Board finances....111
Trawlers for battleships....*147
World's merchant marine....110
MERCURY: remarkable conduct.... 64
METEOROLOGY.
Atmospheres, higher....*233
Aurora, hypothesis of....195
Aurora, what is the....*67
Humidity 231
Lightning *26
Lunar sodiacal light.... 65
METRIC SYSTEM, progress of....195
MILK.
Condensing of milk....*1, 11
Trucking long distances....187
MILKING STOOL, new....*154
MINES AND MINING.
Coal mines, China....267
Levels, a problem in....*198
MISSISSIPPI'S teeth, pulling....*60
MOLYBDENUM steel in motor car.*62
MOP, DUSTLESS....*30
MOTORBOATS.
Harmsworth cup race....*221
MOUNTAINS, California's....267
MT. EVEREST disaster.... 59
MT. EVEREST expedition....127
MOVING PICTURES.
Business organization films.... 85
Film developed automatically...*181
Foreign markets, winning....132
Jutland battle, reconstructing..*43
Re-winding, doing away with..*154
MUD, RIVER, use for....*277

N

NAILS, Cement-coated.... 245
NATIONAL DEFENSE. See also AERONAUTICS, NAVAL AFFAIRS, WARSHIPS, etc.
Armaments offset reparations..142
Disarmament and pacificism....250
Disarmament notes.... 45
Mobilization: economic aspects.184
Needed—a new uniform....*234
NATURAL SELECTION while you wait 126
NAVAL AFFAIRS.
Bombing and naval policy.... 90
Japan and a big Navy.... 75
Model basin and wind tunnel...*82
Noble presidential precedent.... 18
President's opportunity.... 38
Sea power in the Pacific.... 58
NAVIGATION. See MERCHANT MARINE.
NITROGEN. electrical fixation....231
NUTS, oil-bearing.... 59

O

OCHRE, big bed of....143
OIL, getting the rest of the....*114
OIL GUSHER, capping an....*27
OIL, reclaiming used....91
OILS, SHALE....136
OIL that makes wheels go 'round....44
OIL, where occurs....96
ORDNANCE AND ARMOR.
GUNS.
Battery of "Tennessee"....*169
Cannon, electric....251
Coast defense, 16-inch....111
Weapons at sea....*17, 25
PROJECTILES.
Copper-fouling....*197
OSMIRIDIUM....179, 195
OVERALLS BY THE BALE....*119

P

PAINTING with metal spray....*128
PAPER.
Japanese veneer paper....149
Model paper machine....*261
Newsprint from waste....75
Pulp from Australian woods....276
Suit, paper....*170
Wood, substitutes for....66
PATENTS. See INVENTION.
PEARLS IN PLANTS....227
PHONOGRAPHS.
Records, many, without stop....*242
Tone-arm, solid....*14
PHOSGENE, making, safe....28
PHOTOGRAPHY.
Camera, big, Uncle Sam's....*253
Color process, Uva-chrom....225
Industry, photography in....152
Lighting, portable....*262
Photographer's Handy-Andy....*31
PIPE, IRON, bending....*189
PIPE LINES....215
PLANTS. See also AGRICULTURE.
Dead men's fingers....*94
Fruits and nuts combined....*119
Puncture plant....*183
POPPY, JUICE OF THE....*258
PORCELAIN: new cold method....247
PORTS. See HARBORS, DOCKS, etc.
POSTAGE STAMPS, doing away with....*241
POSTAGE STAMPS in the making....*102
POTASH.
Potash from Texas?....199
Putting green sand to work....*40
POTTERY. See CERAMICS.
PREHISTORIC inhabitants, our....*151
PROFESSION, NEW....*196
PROJECTION, DAYLIGHT....*29

R

RACES in the United States....*125
RADIUM.
Chat with Madame Curie....25
Costliest remedy in world....217
Three killed by radium....39
RAILROADS. See also ELECTRICITY.
Alcohol as locomotive fuel..162, 127
Coupling, simplifying....*131
Crossing, planked, eliminating.*265
Deep level rapid transit....142
Electro-traction advantages....231
Electrification....19, 179
Railroading, past and present..*99
Railroading under roof....*112
Rails, life story of....*66
Rail, story of the....*159
Tie plates, steel....169
Track-laying device....*23
Twenty miles a day....148
Weed destroyer, steam as....*261
Wireless control....179
RAKE with a cutter....*86
RELATIVITY.
Einstein, new view of....149
Einstein, said about....248
Magnetic waves and gravity....201
Relativity in 1889....2
RIM DRILLING MACHINE....103
ROADS.
Geologist's part in road building....*180
Illuminated highway....230
Oil stops shifting sands....*83
Pennsylvania's roads....*144
Repairing, technique of....250
Uncharted perils....158
ROCK-CRUSHER, gearless....*277
ROCKING STONE....*13
RUBBER.
Cultivated rubber....*166
Gases, permeability to....28

S

SAFETY. See also FIRES, MINES, INDUSTRY, etc.
Accident statistics....111
SALTON SEA observations....181
SALVAGING equipment, new....*41
SAVING Uncle Sam's pennies....272
SAW, circular, handy....*170
SAW, one-man cross-cut....*103
SCALES, wearing the....*153
SCIENCE.
Rumford fund awards....251
Science coming into its own....24
Smithsonian field work....159
SCIENTIFIC AMERICAN.
Announcement....177
Scientific American landmarks.214
SCREW-DRIVER that holds....*242
SCREW HOLES for brick, etc....*86
SEA, WHY, IS SALT....277
SEWAGE disposal....26
SHEARS, ANGLE, new....*69
SHIPS. See MERCHANT MARINE, and WARSHIPS.
SHOTGUN, "kick"-less....*86
SILK PURSES and sow's ears....*217
SLAG, BLAST FURNACE....273
SOAP, HARD....136
SOAP SCIENCE....133
SODIUM HYPOCHLORITE....108
SOUND ABSORPTION....143
SPITZBERGEN'S RESOURCES....195
STACKS, STEEL....152
STARS. See ASTRONOMY.
STEAM, HIGH PRESSURE....257
STEEL. See IRON AND STEEL.
STOCK quotations by push-button.*115
STONES, PRECIOUS, man-made..*48
SUBMARINES. See WARSHIPS.
SWEET POTATO, uses of....*182
SWIMMING POOL, greenhouse....*241

T

TAR, TESTING....*170
TELEGRAPH. See WIRELESS TELEGRAPHY.
TELEPHONE. See ELECTRICITY.
TELESCOPE, NEW....221
TENNIS BALL, pumping up....*86
TEXTILES.
Clothes, sunlight ages....251
Ramie, degumming of....59
TIME SIGNALS by radio....*186
TOBACCO FIELD, steaming....*83
TOMATO WASTE, utilizing....*161
TOOTH-BRUSH, electric....*226
TOY MAKERS, German, coming...127
TOYS: tin soldiers....267
TRADE. See INDUSTRY AND TRADE.
TRADEMARKS. See INVENTION.
TRANSIT, RAPID, arithmetic....185
TREES AND FORESTRY.
Evergreen transplantation....*30
Soap-nut tree....145
TREMENDOUS....38
TRICKS with bottle and glass....*121
TUNNELS.
How much air for the tunnel?.*42
Hudson River caissons....*252
TYPESETTING MACHINE, new..*241
TYPEWRITERS for blind....*163

U

USE OF USELESS THINGS....126

V

VARNISH that insulates....77
VISE, test, electric service....*154
VITAMINE determination....28
VITAMINES, what are....*76
VOLCANOES. See GEOLOGY.

W

WARFARE. See also AERONAUTICS, NATIONAL DEFENSE, and WARSHIPS.
Mobilization....184
Sham battle: how fought....*259
WARSHIPS.
BATTLESHIPS.
Backbone of the fleet....158
Bomb or battleship?....*4
"Maryland"....*41
"Tennessee," our latest....*169
"Tennessee," trials of....3
Weapons at sea....*17, 25
SUBMARINES.
Bombing a U-boat....*27
SUNDRY.
Hospital, our floating....*48
Sham battle: how fought....*259
WATCH, world's largest....*99
"WATCH YOUR HAT AND COAT"....*31
WATER HYACINTH, fighting the.*200
WATER POWER AND SUPPLY.
Artesian reservoirs....239
Caribou power plant....*146
Clean water for power plant...*118
Foreign projects...39, 127, 143, 215
Household, water power in....*190
Hydraulic power under mile-high head....*22
Hydroelectric plans, U. S....159
Ontario's electric scheme....91
Tidal power....78
WEATHER. See METEOROLOGY.
WELDING: new arc system....75
WINDOW DRESSING....*23
WIRELESS TELEGRAPHY.
Antenna, 1-meter loop....75
Inter-city radio....159
Martian signals, those....194
Masts, concrete....143
Patent, Armstrong, sustained...5
Radio aboard airplane....159
Radio Congress....3
Star to chronometer....*186
Testing radio signals....127
Transmitting photographs....163
Ubiquitous radio....*147
Vacuum tube, 4-electrode....75
WOOD.
Drying wood in Orient....*48
Enemies of timber construction.*118
Timber from live and dead trees.108
WORLD at the crossways....126

X

X-RAY INNOVATION....185

Y

YACHTS AND YACHTING.
America's cup challenge....142
"Britannia," king's yacht....*167

Z

ZEPPELINS. See AERONAUTICS.

INDEX FOR NEW MONTHLY SCIENTIFIC AMERICAN

Because of the change from the former weekly edition to the new monthly, the index for this volume is given in two parts. The foregoing one is devoted to the issues of the regular weekly up to and including the issue of October 15th, while the section that follows below is devoted to the November and the December issues of the new monthly SCIENTIFIC AMERICAN.

A

ADVERTISING.
Trenton's new sign....70
AERONAUTICS.
ACCIDENTS.
Can airplane be made safe?....*28
Helium and the "ZR-2"....69
CONSTRUCTION.
Monoplane, revival of....*111
DIRIGIBLES.
Drag of....141
Ships of air and sea....20
GENERAL.
Flight, new theory of....24
Flying yet not flying....*112
America's First Airway....89
Soaring Man....100
Picture palace, airplane as....72
AGRICULTURE.
Cotton picker, tractor-operated. 61
Harvesting and threshing at once....*54
Harvesting without reaping....*54
Moss scrubber for flumes....*131
Motor Cycle Spraying....*139
Phosphorus, backbone of life...*108
Potato, growing: keeping cool..127
Seeds, oil and albumen content.116
ANATOMICAL ARTISTRY....*131
ANIMALS.
Snakes, venomous, studies of...119
Study in offspring herds....*46
ARCHAEOLOGY.
Abraham's birthplace....72
Prehistoric Sculpture....*86
ARCHITECTURE. See BUILDING CONSTRUCTION.
ARMY. See NATIONAL DEFENSE.
ASTRONOMY.
COMETS.
Comets....*136
GENERAL.
Heavens in November....*58
Heavens in December....*136
MOON.
Moon....80, *136
PLANETS.
Jupiter and others....80, *136
TELESCOPES.
Heavens in November....*58
ATOMIC ENERGY, control of....21
AUTOMOBILES.
ACCESSORIES AND SUNDRIES.
Bumpers, garage, portable....*56
Meter, wireless, for testing....*60
Posting the driver behind....*61
Thief-proof alarm....*60
FUELS.
Acetylene as motor fuel....125
GENERAL.
Cleaning Closed Car....*138
Fire Department Motorized....139
Mirror for motor cop....*56
Service Station Traveling....*141
Theft-Proof Car....*138
Tours and detours....*6
Wheels, moving....*66
PLEASURE CARS.
How to keep a car....39
TIRES.
Truck tire building, engineering in....117
TRACTORS.
Trailer to carry tractor....*62

B

BALLOONS. See AERONAUTICS.
BATTLESHIPS. See WARSHIPS.
BIOGRAPHY, including OBITUARIES.
Moore, E. H....*137
Stone, W. E....72
Wurts, Adolphe....76
BOOK REVIEWS....148
BOTANY. See PLANTS.
BRIDGES.
Architecture, bridge....*22
Lengths, economic....74
San Francisco bay, crossing...*120
BUILDING CONSTRUCTION.
Building code, nation-wide....*42
Concrete building, tallest....75
Concrete construction, climax in....*132
BUSINESS. See INDUSTRY AND TRADE.

C

CARBON BLACK in 1920....76
CARBON MONOXIDE indicators...134
CARBURETOR for light oils....59
CARPET RENOVATOR....*138
CARUSO, posterity to hear....71
CEMENT, South Africa....74
CHEMISTRY.
Applied chemistry notes....76
Service of the chemist....57, 134
Volatile, chemistry of the....10
CIVIL ENGINEERING NOTES.74, 157
CLIFF DWELLERS....66
COAL. See FUELS, and MINES AND MINING.
CONCRETE. See BUILDING CONSTRUCTION, ROADS, etc.
CORRESPONDENCE. See READERS' POINT OF VIEW.
CRICKET, the, on the wire....13
COTTON ROLLING MACHINE..*139

D

DAMS.
Making flood dam itself....*38
DISKS, ROTATING....66
DOCKS. See HARBORS.
DRAFTSMAN'S LOAD, lightening....44, *45
DRUMS, TWO, IN ONE....*61
DYES AND DYEING.
Malt extract....57
National welfare, dyes and....57

E

EASEL, FROM, TO COVER....*18
EDITORS, WITH THE....2
EDUCATION.
College, self-supporting....130
Hydro-electric course....74
What do you know?....16
EGG CARTONS from coffee containers....*61
ELEVATOR and "Defectoscope"....51
ELECTRICITY.
MISCELLANEOUS.
Notes, electrical....70, 151
Photo-electric cell, new....70
Role of Research....*88
Shoe-Shining Device....*141
Sunday Pictures by Wire....140
Where more voltage means more distance....*59
TELEPHONES.
Radio link, the....*40
ENGINEERING.
Disasters, value of....21
EXPLOSIVES.
Dynamite, non-freezing....76
TNT for road building....76

F

FABRICS under microscope....*35
FARMING. See AGRICULTURE.
FILE, Safety....*139
FIRE ALARM, Smoke....137
FIRES AND FIRE PREVENTION.
Doors, automatic-closing....61
Static and gasoline fires....*135
Tests of building columns....121
FISH AND FISHERIES.
Devil-fish, truth about....*53
FLOOD, making, dam itself....*38
FOOD.
Bread making....76
Syrup from sugar beets....76
FRUITS. See also AGRICULTURE, FOOD, etc.
Banana and its uses....*118
FUELS. See also AUTOMOBILES.
Engine fuel, new....27
Light oils, carburetor for....59
Power plants, grouping our....30

G

GASOLINE. See AUTOMOBILES and FUELS.
GEAR CUTTING: Maag system....68
GEAR TEETH TESTING....68
GLYCERINE from sugar....49
GOLD; a wilderness industry....*126
GRINDING WHEELS: speeding...68
GUNS. See ORDNANCE AND ARMOR.

H

HARBORS, DOCKS, ETC.
Paris, port of....74
San Francisco bay, crossing...*120
HOUSES. See BUILDING CONSTRUCTION.
HYDROELECTRIC POWER. See WATER POWER AND SUPPLY.

I

INCLINOMETER, PRECISION...*141
INDIANS' LIVING CONDITIONS. 71
INVENTION AND PATENTS.
Balkans, patents in....73
Employer and employee....73
Foreign-infringer protection....73
Holland's patent law....73
Interferences....73
Inventions new and interesting.*80
Inventions, recently patented, *63, *142
Patent Notes....150
Patents and trademarks....73
Trademark, abandoned....73
Trademark fundamentals....73
Trademarks in China....73
IRON AND STEEL.
Stainless Iron....99
Steel direct from ore....44
Steel: why weary metal fails..*109
IRRIGATION. See AGRICULTURE.

L

LEATHER.
Cement for leather....76
Pelt dyeing....134
Tannage, mineral....134
LIGHT IN WATER....57
LIGHT speeds up vision....*131
LINOTYPE SLUGS and catalogues. 47
LIQUID AIR....87
LOCOMOTIVES. See RAILROADS.
LUMBER.
Oriental demand....107

M

MACHINE PARTS, standardized... 68
MAIL MACHINE, revolutionary....69
MAP'S other name is Ananias....*124
MECHANICAL ENGINEERING NOTES....68
MECHANICS.
Micrometer, Internal....*138
Micrometer, Swivel Arm....139
MEDICINE AND SURGERY.
Shock, physiological nature of.. 52
MERCHANT MARINE.
"Big five," the....*5, *9
Propulsion of ships....74
Salvage system, new....*32
METALS: Schoop process....68
METHANOL FROM METHANE..134
MINES AND MINING.
Dump-heap goes to work....*55
Wilderness industry....*126
MISCELLANEOUS NOTES....149
MOSS SCRUBBER....*131
MOTORCYCLES.
Keeping hands indoors....*56
Motor wheel, German....*60
MOVING, business as usual while...*27
MULTIPLICATION MACHINE....*62
MUSICAL INSTRUMENT, self-teaching....*61

N

NATIONAL DEFENSE. See also AERONAUTICS, NAVAL AFFAIRS, WARSHIPS, etc.
"One-age" companies....69
NAVIGATION. See MERCHANT MARINE.
NECKTIE CARRIER....*140
NEWS, our Niagara of....69
NICKEL, pure, rolling....*34
NITROGEN, pure, from air....34
NOTES AND QUERIES....77, 155
NOTES, MECHANICAL....153
NOTES, MISCELLANEOUS....69, 71

O

OIL CUPS, improvement in....60
OIL SHALE in Palestine....105
OPIUM, from, to hashesh....*14
ORDNANCE AND ARMOR.
GUNS.
Sixteen-Inch Gun....*98, 101
4000-Pound Bomb....*94
French suggest 200-mile gun...*48
Power of gun and of thunder.. 49
PROJECTILES.
Mechanics of ordnance figures..105
ORGAN, PIPE, mechanism of....*113

P

PAINT, FIREPROOF....76
PATENTS. See INVENTION AND PATENTS.
PHONOGRAPHS.
Attachment, another....*60
Needle shaped like pen....123
PHOSPHORUS, backbone of life..*108
PHOTOGRAPHY.
Camera turned sculptor....*135
Exposure at a glance....*61
Motion Camera Parts, Drying..*140
PILEDRIVER extraordinary....74
PLANTS. See also AGRICULTURE.
POINT OF VIEW, OUR....20
POWER.
Gas Turbine Perplexities....101
Power Plants, grouping our....30

R

RADIO-ACTIVITY, rain and....32
RAILROADS. See also ELECTRICITY.
Bumper that slides along track.*62
Locomotive operation, recording.*52
RAILWAYS.
Railways of the World Compared *85, 91
READERS' POINT OF VIEW, OUR....*66
RESEARCH, Role of....*88
RIVET-CUTTING GUN....68
ROADS.
Detours, marking the....*56
Tours and detours....*6
ROCK CRYSTAL BALLS....125
ROPE SELLING TABLE....*138

S

SAFE-BREAKING, Science in....*92
SALVAGE. See MERCHANT MARINE.
SCIENTIFIC AMERICAN.
Aim, our....20
From easel to cover....*18
SCULPTOR, camera turned....*135
SCULPTURE PREHISTORIC....*86
SEAT, Diagram, Illuminated....*139
SHIPS. See MERCHANT MARINE, and WARSHIPS.
STACK-WRECKING PROBLEM...*81
STADIUM, Gigantic....*99
STEEL. See IRON AND STEEL.
STONES ABSORB WATER....70
STOPPER, BOTTLE....*141
SUGAR.
Story of sugar....*128

T

TABLE, FOLDING, NEW....*61
TELEGRAPH. See ELECTRICITY and WIRELESS.
TELEPHONE. See ELECTRICITY.
TEXTILES.
Fabrics under microscope....*35
Textiles, Testing of....*141
TRADE. See INDUSTRY AND TRADE.
TRADEMARKS. See INVENTION.
TRAFFIC police, automatic....*80
TRANSLATION, Gentle Art of....100
TREES AND FORESTRY.
Molds and wood destroyers....112
Reforestration activities....*106
TUNNELS.
Bridge vs. tunnel, Hudson....75
San Francisco bay, cross....*120
Selkirks, tunneling the....*50

V

VISE TEST, severe....68
VOLCANOES. See GEOLOGY.

W

WARFARE.
Armies of the World....*96
From trireme to dreadnought..*25
Western front, films of....69
WARSHIPS.
BATTLESHIPS.
Britain's New Battle Cruisers..*90
From trireme to dreadnought..*25
High-Speed Fighting Ships....97
Naval strength of the United States, Great Britain and Japan....*11
Navy, as equal to any....21
WATER POWER AND SUPPLY.
Energy from waste water....66
High-tension distribution....70
Mexican power plants....74
WEATHER. See METEOROLOGY.
WHAT DO YOU KNOW?....16
WHEELBARROW, FOLDING....*80
WIRE GAGE by memory....78
WIRELESS TELEGRAPHY.
Adhesion, electrostatic....41
British world-wide radio....78
Extemporized radio....74
Looking Forward or Backward.100
News and Music from the Air.*104
Osiris prize award....70
Transatlantic amateur tests....70
WIRE ROPE FRACTURES....93
WORMS, MARINE: how they catch their prey....*122

X

X-RAYS.
Plate, X-ray, new....70

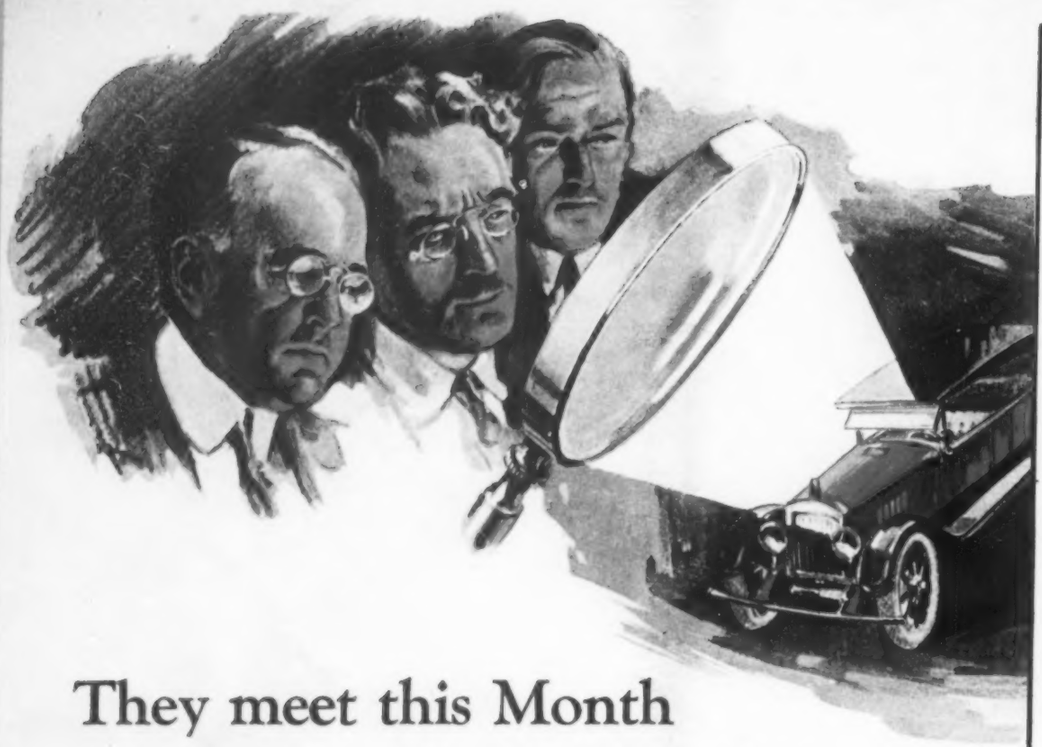
Y

YACHTING.
Last Voyage of America

Z

ZIRCONIUM....137

Yes, Sir!
I HAVE to make special trips to supply all the people who want Murads for Christmas gifts.
MURAD
THE TURKISH CIGARETTE
S. ANARGYROS.
CAPITAL STOCK OWNED BY P. LORILLARD CO.
20



They meet this Month

The correct lubricating oil for 1922 cars will be determined in December

DURING this month the Annual Meeting of the Vacuum Oil Company's Board of Automotive Engineers is being held.

These men meet for joint consideration of the 1922 models of automobiles, motor trucks, farm tractors, motorcycles and stock engines. They will determine the correct lubricating oil for each.

Perhaps the most striking single proof of the qualifications of the Board is this:

As members of the Vacuum Oil Company's Board of Engineers these men have repeatedly been consulted by automobile manufacturers in regard to engine design. Important engine features and improvements have often resulted.

* * *

After detailed examination of the specifications of each 1922 model, the Board of Engineers will specify for its engine and for its transmission and differential the correct grade of Gargoyle Mobiloils. This grade will be selected to insure

[1] *Free distribution to every frictional surface*

[2] *Full compression*

[3] *Fuel economy*

[4] *Oil economy*

[5] *Greatest freedom from carbon*

[6] *Maximum power*

[7] *Longest life*

The lubricating requirements of each engine will be scientifically met by the high quality and correct body and character of the oil recommended. As quickly as possible, these findings will be put in Chart form for distribution among motorists and to the trade.

Automobile lubrication was a matter of guesswork until the Chart first appeared in 1905. The Chart makes automobile lubrication a science. There are laws of lubrication as exact as the laws of physics or mathematics. These laws are put into practice in the production of Gargoyle Mobiloils and the Vacuum Oil Company's complete Chart of Recommendations.

Make this Chart your guide. The correct lubricating oil for your 1922 car will be determined this month. The Chart on the right shows the correct oil for previous models.

GARGOYLE

Mobiloils

A grade for each type of motor

Domestic Branches	New York *(Main Office)*	Boston	Chicago	Philadelphia	Detroit	Pittsburgh
	Indianapolis	Minneapolis	Buffalo	Des Moines	Dallas	Kansas City, Kan.

Chart of Recommendations

(Abbreviated Edition)

How to Read the Chart:

THE correct grades of Gargoyle Mobiloils for engine lubrication of both passenger and commercial cars are specified in the Chart below.

A means Gargoyle Mobiloil "A"
B means Gargoyle Mobiloil "B"
E means Gargoyle Mobiloil "E"
Arc means Gargoyle Mobiloil Arctic

Where different grades are recommended for summer and winter use, the winter recommendations should be followed during the entire period when freezing temperatures may be experienced.

The recommendations for prominent makes of engines used in many cars are listed separately for convenience.

The Chart of Recommendations is compiled by the Vacuum Oil Company's Board of Automotive Engineers, and represents our professional advice on correct automobile lubrication.

NAMES OF AUTOMOBILES AND MOTOR TRUCKS	1921		1920		1919		1918		1917	
	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Ace (Newark, O.) (1½ ton)	A	Arc	A	Arc						
" " All Other Models	A	A	A	A	A	A				
Allen	A	Arc	A	Arc	A	Arc	A	Arc	A	Arc
American Six	A	Arc	A	Arc	A	Arc	A	Arc	Arc	Arc
Apperson (8 cyl.)	A	A	A	A	A	A	A	A	A	A
" All Other Models							A	Arc	Arc	Arc
Auburn (6 cyl.)	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
" (6-36)									A	Arc
" (6-39-B) (Tractor H. Eng.)						A	Arc			
Bour Davis	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
Briscoe	A	Arc	A	Arc	A	Arc	A	Arc	A	Arc
Buick	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
Cadillac	A	A	A	A	A	A	A	A	A	A
Case	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	A	Arc
Chalmers	A	A	A	A	A	A	A	A	A	A
Chandler Six	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
Chevrolet (4 cyl.)		A		A	A	A	A	A	A	A
" (Model 490)	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
" All Other Models	A	Arc		A	Arc	A	Arc			
Cleveland	A	Arc		A	Arc					
Concord	A	A	A	A	A	Arc	A	Arc	A	Arc
Corbitt (5 ton)	A	A	A	A	A	Arc	Arc	Arc		
" All Other Models	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
Crow-Elkhart	A	Arc		A	Arc	A	Arc	A	A	Arc
Cunningham	A	A	A	A	A	A	A	A	A	A
Daniels	A	A	A	A	A	A	A	A	A	A
Dodge Brothers	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
Elcar (4 cyl.)	A	Arc	A	Arc	A	Arc	A	Arc	A	Arc
" (6 cyl.)	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc		
Essex	A	Arc	A	Arc	A	Arc				
Fiat							B	A	B	A
Ford	E	E	E	E	E	E	E	E	E	E
Franklin	A	A	A	A	A	A	A	A	A	A
Fulton	A	Arc	A	Arc	A	Arc	A	Arc	Arc	Arc
Grant (6 cyl.)	A	Arc	A	Arc	A	Arc	A	Arc	A	Arc
" (Com.) (Model 12)					A	Arc				
" All Other Models	Arc	Arc	Arc	Arc	Arc	Arc				
Hahn	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
Haynes (6 cyl.)	A	Arc	A	Arc	A	Arc	A	Arc	A	Arc
" (12 cyl.)	A	A	A	A	A	A	A	A	A	A
Holmes	A	A	B	A						
Hudson Super Six	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
Hupmobile	A	Arc	A	Arc	A	Arc	A	Arc	A	Arc
Jackson (4 cyl.)	A	Arc	Arc						Arc	Arc
" All Other Models	Arc	Arc	Arc				A	A		
Kissel Kar (12 cyl.)							A	A	A	A
" All Other Models	A	Arc	A	Arc	A	Arc	Arc	Arc	Arc	Arc
Kline Kar	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
LaFayette (Indianapolis)	A	A	A	A						
Lexington (Continental Eng.)	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
Liberty	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
Lincoln	A	A								
L. M. C.	Arc	Arc	Arc	Arc	Arc	Arc				
Locomobile	A	E	A	E	A	E	A	E	E	E
McLaughlin-Can. (Mod. 44 to 50)	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
All Other Models	A	A	A	A	A	A	A	Arc	Arc	Arc
Marmon	A	A	A	A	A	A	A	A	A	A
Maxwell	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	A	A
Mercer	A	A	A	A	A	A	A	A	A	A
Mitchell	A	Arc	A	Arc	A	Arc	A	Arc	A	Arc
Monitor	A	Arc	Arc	Arc	Arc	Arc	Arc	Arc		
Moon	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
Nash	Arc	Arc	A	Arc	A	Arc	A	Arc		
" (Model 671)							A	A		
" (6 Cyl.) (Quad)	A	A	A	A	A	A	A	A		
" (1 ton & 2 ton)	A	Arc	A	Arc	A	Arc	A	Arc		
National (6 cyl.)	A	A	A	Arc	Arc	Arc	Arc	Arc	Arc	Arc
" (12 cyl.)				A	A	A	A	A	A	A
Overland	A	Arc	A	Arc	Arc	Arc	Arc	Arc	Arc	Arc
Owen Magnetic (Mod. M25)					Arc	Arc	Arc	Arc	Arc	Arc
" All Other Models	A	A	A	A	A	A	A	Arc	A	Arc
Packard	A	A	A	A	A	A	A	A	A	A
Peerless (8 cyl.)	A	A	A	A	A	A	A	A	A	A
" All Other Models							Arc	Arc	Arc	Arc
Pierce-Arrow	A	A	A	A	A	A	A	A	A	A
" (Cont.) (5 ton)	A	A	A	A	A	Arc	Arc	Arc	Arc	Arc
" " All Other Models	A	A	A	A	A	Arc	Arc	Arc	Arc	Arc
Premier	A	A	A	A	A	A	A	A	A	A
Renault (French)	A	A								
Reo	A	Arc	A	Arc	A	Arc	A	Arc	A	A-E
Roamer (Model R. A.)									A	Arc
" (Model 6-75)	A	A								
" All Other Models	Arc	Arc	Arc	Arc	Arc	Arc			Arc	Arc
Rolls Royce (British)									A	A
Rowe	A	A	A	A	A	A	A	E	A	A
R. & V. Knight	B	A	B	A					A	A
Saxon	A	Arc	A	Arc	E	E	E	E	E	E
Sayers-Scott	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
Singlers Crane							A	A	A	A
Standard (8 cyl.)	A	A	A	A	A	A	A	A	A	A
Stearns-Knight	B	A	B	A	B	A	B	A	A	A
Stephens	A	A	A	A	A	A	A	A	Arc	Arc
Stoughton (1 ton and 1½ ton)	A	Arc	A	Arc						
" All Other Models	A	A	A	A						
Studebaker	A	A	A	Arc	A	Arc	A	Arc	A	Arc
Stutz	A	A	A	A	A	A	A	A	A	A
Sullivan	A	A	A	Arc	A	Arc	A	Arc		
Templar	A	A	A	A	A	A	A	A		
Traffic	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc		
United (Mich.) (2½, 4, 5, 6 ton)	A	A	A	A	A	A	A	A	A	A
" " (1½ ton)	A	A	A	A	A	A	A	A	Arc	Arc
" " All Other Models	A	Arc	A	Arc	A	Arc	A	Arc	Arc	Arc
U. S. (Cin. O.) (1½ ton)	Arc	Arc	Arc	Arc						
" " (5 ton)	A	A	A	A	A	Arc	A	Arc	A	Arc
" " All Other Mods.	A	Arc	A	Arc	A	Arc	Arc	Arc	Arc	Arc
Watson (1½ ton and 1½ ton)	A	Arc	A	Arc						
" (2½ ton)			A	A						
" All Other Models			Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
White (16 valve)					A	A	A	A	A	A
" (3 and 5 ton)	A	A	A	A	A	A				
" All Other Models	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
Willys-Knight	B	A	B	A	A	Arc	A	Arc	A	Arc
Willys Six					Arc	Arc	Arc	Arc	Arc	Arc
Winther Six	A	Arc	A	Arc						
" (Cont'l) (1½ ton)	A	A								
" All Other Models	A	A	A	A	A	A	A	A	A	A
Winther-Marwin (1½ ton)	A	A	A	A	Arc	Arc				
" " All Other Models	A	A	A	A	A					
Winton	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc

Prominent Makes of Engines

Beaver (Models J-14-J Band JC)	A	A	A	A	A	A	A	A		
" All Other Models	A	Arc	A	Arc		A	Arc	A	A	Arc
Buda (Models ATU-BTU-CTU-DTU-ETU-FTU-GU-HTU-IU-ITU-XU-XTU-YU-YTU	A	A	A	A	A	A	A	A	A	A
Buda All Other Models	A	Arc	A	Arc	A	Arc	A	Arc	A	Arc
Continental (Model B2)	A	A	A	A	A	A				
" (Model T)					A	Arc	A	Arc	A	Arc
" All Other Models	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
Falls	A	Arc	A	Arc	A	Arc	A	Arc	A	Arc
G. B. & S. (Model AA)	A	A	A	A	A	A				
" All Other Models	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
Herschell-Spillman										
" Models JU-6-V and VA					A	A	A	A	A	A
" All Other Models	A	Arc	A	Arc	A	Arc	A	Arc	A	Arc
Hinkley	A	A	A	A	A	A				
Lycoming	A	Arc	A	Arc	A	Arc	A	Arc	A	Arc
Northway (Model 10R)									Arc	Arc
" All Other Models	A	K	A	A	A	A	A	A	A	A
Rochester (Duesenberg)	A	A	A	A						
Waukesha (Models CU-DU-EU & FU)	A	A	A	A	A	A				
" All Other Models	A	Arc	A	Arc	A	Arc	A	Arc	A	Arc
Weidely	A	A	A	A	A	A	A	A	A	A
Wisconsin (Models Q & QU)					A	Arc	A	Arc	A	Arc
" All Other Models	A	A	A	A	A	A	A	A	A	A

VACUUM OIL COMPANY